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The *Bulletin* serves as a means of communication between the Department of Defense, its authorized agencies, defense contractors and other business interests. It provides guidance to industry concerning official DOD policies, programs and projects and seeks to stimulate thought on the part of the Defense-Industry team in solving problems allied to the defense effort.

Suggestions from industry representatives concerning possible topics for future issues are welcome and should be forwarded to the Editor at the address shown below.

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IN THIS ISSUE

FEATURES

DEPARTMENTS

Snow covered Alaskan mountains profile a CH-54 Flying Crane helicopter as it logs test hours. The helicopter proved versatile, reliable and adaptable in the extremely cold climate. An article on the activities of the U.S. Army Arctic Test Center begins on page 20.

Weapon Systems Planning

James Bain Jr.
Lieutenant Colonel Edward Shabsin, USAF

The nationally important goal of acquiring effective and economical weapon systems is worthy of the best management concept available. For this reason, system/project management is used throughout the Defense Department to acquire costly and complex weapon systems. This management concept centralizes authority to make decisions together with expertise to perform two integrated system management functions, which we shall call *systems planning* and *programming-budgeting*.

Systems planning helps the system manager determine what system shall be acquired and used. It is product related and needs oriented. It translates the approved statement of need to a *system plan*, which continually defines and refines the technical design and logistical support of the system during the life cycle phases. In the conceptual phase, the best conceptual system is defined by a set of technical design and logistical support concepts. In the contract definition and development phases, the best system configuration is defined by a set of technical characteristic and support element parameters. Finally, in the production and operation phases, the best system modifications are defined to update technical characteristics and support elements of the operational system.

Programming-budgeting helps the system manager determine what organizational tasks shall be accomplished to develop, produce, deploy, operate, and support the approved system. It is operations related and resources oriented. It translates the approved system plan to a *master plan*, which continually defines and refines the schedule, cost, and scope of all work to be performed by supporting government organizations and defense contractors during the life cycle phases. The master plan is constrained by the available resources of the Five Year Defense Program (FYDP).

Both system and master plans must be continually controlled during the life cycle to respond to changing needs and resources. An effective system manager cannot blindly adhere to static and inflexible plans in an environment of uncertainty and change. Dynamically changing threats produce changes in the needs, producing changes in the system plan which may change the master plan. Correspondingly, changes in available resources change the master plan, which may change the system plan. Clearly, the system plan and master plan are interactive and inseparable as they undergo continuous refinement and change during the life cycle.

This article presents an *approach* to the systems planning function of weapon system/project management. Programming-budgeting will not be considered because there is more than ample literature on this function which uses concepts of network planning, critical path analysis, and exception reporting. In contrast, systems planning has been almost completely ignored.

Weapon systems planning can be described by what it does. It generates the information needed by the system manager to make logical system decisions, and to communicate the logic of his decisions to higher authority for conditional approvals of the system plan.

It can also be described by how it is accomplished. It uses a formal decision-making process, quantitative value criteria, analytical methods and tools, and interdisciplinary skills, under the guidance of the system manager.

A description of what is involved in weapon systems planning presents a more comprehensive view than a mere statement of its purpose. We shall, therefore, briefly examine system planning in terms of its:

- Formal decision-making process.
- Quantitative value criteria.
- Analytical methods and tools.
- Interdisciplinary skills.
- Planning-briefing-guidance cycle.

Formal Decision-Making Process

The keystone of good systems planning is a formal, deliberate, systematic decision-making process, illustrated in Figure 1 (page 2). The six steps of this procedure are elaborations of generalized decision making in any field. The usual steps of defining the problem, developing and analyzing solutions, and selecting the best, are expanded here to six steps, to describe in greater detail the process applied in weapon systems planning.

A brief explanation of the purpose of each step of this formal decision-making process may be helpful at this point:

- *Definition step* defines what oper-

Formal Decision-Making Process Used in Weapon Systems Planning

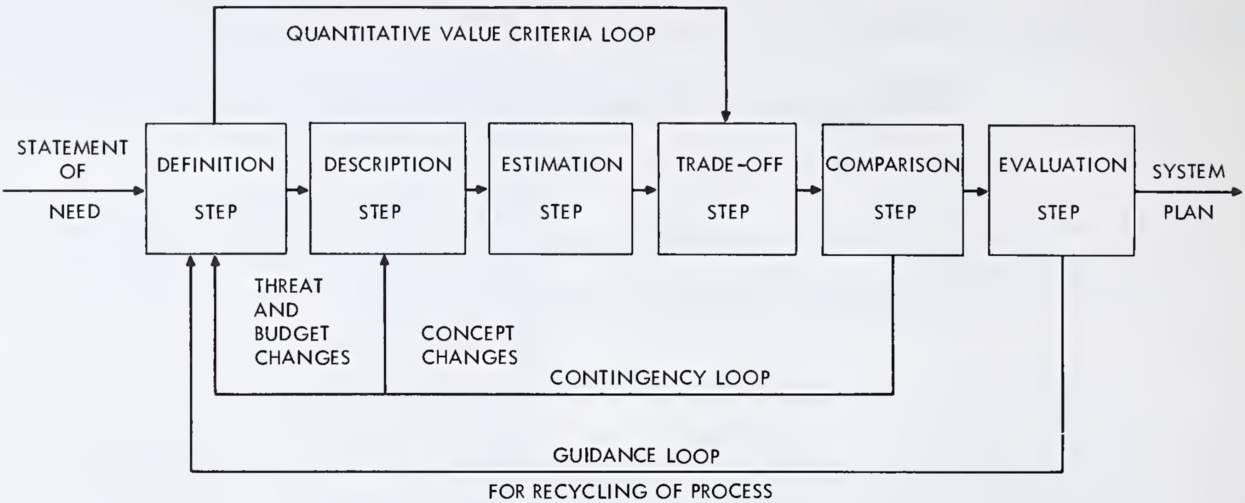

Figure 1.

ational characteristics will be needed by the system to perform specified missions against assumed threats; what life cycle cost can be afforded for acquisition and operation of a specified operational quantity of the system for assumed budgets; and what utility[1] value criteria will be used to compare the mission performance, life cycle cost, and operational schedule of alternative systems.

- *Description step* generates and describes conceptual systems which may satisfy the mission performance requirements. A system description includes its technical/support concepts and technical characteristic/support element measurements.
- *Estimation step* estimates the operational characteristics, life cycle cost, and operational schedule of all possible combinations of technical characteristic/support element measurements of each conceptual system.
- *Tradeoff step* optimizes the technical characteristic/support element measurements of each conceptual system based upon the utility value criteria.
- *Comparison step* compares the utility values of alternative systems for *each* change in technical/support concept, threat, and budget.
- *Evaluation step* provides the decision maker with the expected utility values and risks of the alternative systems among *all* assumed threat and budget contingencies. This information combined with the decision maker's judgment of whether or not the consequences are acceptable leads to a decision to either continue systems planning or select a system which is effective and economical enough to satisfy the requirements.

The primary advantage of this formal decision-making method is that it generates expected value and risk information needed to select the best system, and to justify the logic of that decision to higher authority. While intuition is, no doubt, inherent in the formal decision-making process, the complexity of modern day weapon systems exceeds the ability of a decision maker to intuitively make the right decision. The multiplicity of factors and their interreactions are beyond the comprehension of the intuitive mind. Further, information based solely on intuition is seldom subject to logical scrutiny and formal justification. Unless higher authority can be convinced by rationally acceptable information that a chosen system offers the most advantageous combination of value and risk, the system plan will not be approved. The penalty for not using a formal decision-making process is delay after delay of approvals, until the system is cancelled.

Another advantage of the formal decision-making process is that valuable executive time and effort can be saved by delegating the work of generating decision information to specialists. A weapon system manager never has all the expertise and time needed to generate information for total decision making; therefore, he must convert to procedure what he has done before by intuition. A specialist has particular expertise, and he can be given the time to perform the work called for by the procedure. Under the guidance of the weapon system manager, a team of specialists can pool their knowledge, judgment, and skills to help solve complex system problems. They can also use the powerful tools of mathematical analysis, information processing, and independent estimates to reduce uncertainty of numbers and assumptions.

While the weapon system manager does not have to do the work of specialists, it is essential that he fully understand the decision-making proc-

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[1] *"Utility means usefulness, the satisfying of a need. A decision or an outcome has high utility when it satisfies the need as well as it can with available resources." J. Morley English, ed.,* Cost-Effectiveness, The Economic Evaluation of Engineered Systems, *p. 84.*

ess to be able to use the expertise of specialists. He must know the why, who, when, where, and what (but not necessarily the how) of the system decision-making process. He must know why it is important that it be used, and what specialists are needed to do what jobs. He must also know when and where analytical methods and tools should be used. Specialists are trained to know how to use those essential methods and tools. Simply, the formal decision-making method is a "harness" within which a system manager integrates the efforts of his specialists to generate the decision information he needs.

Quantitative Value Criteria

There are three quantitative value criteria used in the formal decision-making process. These are:

• *System effectiveness*—the *military value* of the improvement in mission performance achieved by a system alternative, at the time of its deployment against an assumed threat. It can be measured on a utility scale between 0 (the military value of the mission performance of the existing system), and 100 (the military value of the mission performance needed in an improved or new system, at the required time of deployment). An effectiveness measure of 80, for example, indicates a given system will achieve 80 percent of the performance improvement needed, but 20 percent additional improvement is still desired.

• *System economy*—the *budgetary value* of the incremental life cycle costs conserved by a system alternative at the time of its deployment, and for an assumed budget ceiling. It can be measured on a utility scale between 0 (the budgetary value of the inherited plus the incremental funds which is the ceiling that higher authority can afford to spend for an improved or new system), and 100 (the budgetary value of the funds inherited from the existing system at the time it is replaced). The future costs of operating and maintaining the existing system are inherited by the new system, when it replaces the old. These budget funds have already been allocated by *previous* decisions. Incremental costs are the additional future funds needed by the new system. These budget funds must be allocated by *future* decisions. Therefore, an economy measure of 85, for example, indicates a given system will conserve 85 percent of the maximum incremental life cycle funds that can be afforded.

• *System worth*—the *national value*, or the sum of the weighted effectiveness and economy, of a system alternative at the time of its deployment, and for an assumed combination of threat and budget. It is also measured on a utility scale between 0 and 100. The mathematical expression for system worth (WORTH) is:

$$\text{WORTH} = w\text{EFF} + (1-w)\text{ECON}$$

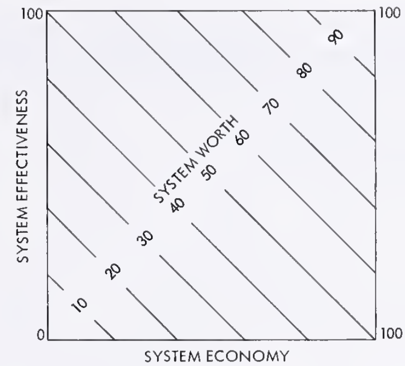
where,

EFF = system effectiveness
ECON = system economy
w = relative importance of system effectiveness compared to system economy, *i.e.*, weighting factor.

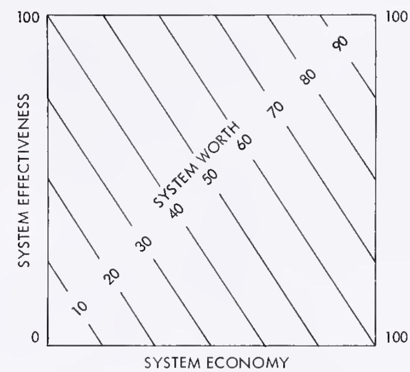
The relationship between system effectiveness, economy, and worth is graphically illustrated in Figure 2. Figure 2a shows the relationship when the importance of system economy and system effectiveness are equal. Figure 2b shows the relationship when system economy is more important than system effectiveness, *i.e.*, in a period of austerity.

System worth is a very important compromise criterion. Usually a decision to select a system is a compromise between what performance is needed, and what cost can be afforded. Military users want a system with maximum effectiveness. A decision to select a system with either maximum effectiveness or maximum economy will seldom satisfy both the military and budgetary points of view. The criterion of system worth is, therefore, necessary to represent the national interest point of view. This compromise provides the maximum system effectiveness that can be afforded by the anticipated available dollars.

Quantitative value criteria of system effectiveness, economy, and worth are mandatory for the calculation of the military, budgetary, and national values, respectively. For any assumed threat, there is an effectiveness value of performance (or a military value) of each system alternative. For any assumed budget, there is an economy value of life cycle cost (or budgetary value) of each system alternative. For any assumed combination of threat and budget, there is a worth value (or a national value) of each system alternative. These quantitative values inform a weapon system manager of the expected values of system alternatives. He must then judge whether a system alternative is valuable enough to select and attempt to justify.



2a EQUAL WEIGHTING OF PERFORMANCE AND COST
WORTH = .5EFF + .5ECON



2b COST WEIGHTED MORE IMPORTANT THAN PERFORMANCE
WORTH = .4EFF + .6ECON

Figure 2.

Quantitative value criteria are equally necessary for the calculation of the expected risk of system alternatives among all anticipated contingencies. Effectiveness and economy values of system alternatives will change as changes in future situations occur. It is logical to choose a system alternative with maximum value, contingent upon the occurrence of the most likely situations. But, if those situations do not occur, then the system alternative may have a lesser

value in other situations. This introduces risk into system decision making. Risk is the loss of system value which results from predicting the wrong future situations or contingencies. It can be determined by calculating the difference between system values across all anticipated contingencies.

The formal decision-making process combined with the quantitative value criteria is often referred to as the "quantitative decision-making process." This means that both numbers and procedure are inseparable in system planning. Procedure without numbers prevents a weapon system manager from using specialists with their new and powerful analytical methods and tools. On the other hand, numbers without procedure lead to overemphasis upon analytical methods and tools. One becomes mesmerized by sophisticated mathematics, and is consumed by the cannibal appetite of their insistent promoters.

A weapon system manager must understand the quantitative value criteria which are used to inform him of the expected values and risks of each course of action. He must also be able to use these numbers to convince higher authority of the rationality of his system decisions to obtain the conditional decision for engineering development, ratification of that conditional decision, and approval for production of the system.

Analytical Methods and Tools

The quantitative decision-making process requires the use of modern analytical methods and tools. These methods and tools, and their purposes, are:

Utility theory. This method is used to quantify the *relative* importance of performance, cost, and schedule requirements in assumed situations. Quantified value judgments are used to calculate the utility value criteria of system effectiveness, economy, and worth. Remember that performance, cost, and schedule measures themselves reveal nothing about their relative value. It is a simple truism that one can know the performance, cost, and schedule of everything, but the value of nothing.

The effectiveness of mission performance must be judged by military experts who have to use that performance against a future threat. The weight of effectiveness of performance compared to the economy of cost must be judged by excutives who will approve both the system to be acquired and the resources to acquire and operate it.

In the past, performance, cost, and schedule have not been translated to commensurate scales; therefore, they could not be related to obtain meaningful value criteria. The use of utility values for performance and cost, however, provides the means whereby they can be mathematically combined into system effectiveness and economy criteria, which are commensurable and, more important, which consider the effects of schedule or time upon the effectiveness and economy values.

Discounting. This technique is used to determine the effects of time upon system effectiveness, economy, and cost values. Effectiveness and economy are discounted to the required time of deployment, *i.e.*, operational readiness date. A delay in the deployment schedule of a given system will reduce its effectiveness by an obsolescence rate. If a new system, intended to replace an existing system, is delayed in deployment, its economy will be reduced by the loss of those funds needed to continue the operation and support of the existing system beyond its intended life.

Life cycle cost is discounted to present dollar value by a discount rate. DOD Directive 7041.3 describes cost discounting and prescribes a discount rate of 10 percent.

Mathematical models. This tool is used to represent criteria, systems, and tradeoffs. There are nine different mathematical models which are developed in the quantitative decision-making process. These models can be classified by what they represent as tabulated in Figure 3. Criteria models of effectiveness, economy, and worth are used to estimate the value of the performance, cost, and schedule of a given system in assumed threat and budget contingencies. System models of design, support, and cost are used to estimate the performance, cost, and schedule of alternative systems. Finally, tradeoff models are used to estimate the optimum technical characteristics and support elements of each alternative system.

Simple sketches are among the essential tools for developing mathematical models. For example, a cost analyst can explain and illustrate what his cost model does by using a three dimensional sketch shown in Figure 4. The cost model estimates the life cycle cost of all feasible combinations of technical characteristics and support elements between the limits of the most economical (cheapest) and maximum attainable configuration and support. It first estimates the base cost of the most economical configuration and support. Next, it estimates the cost increase for the improved configuration. Finally, it estimates the cost increase for the improved support. The cost model sums the base cost and additional cost of

Mathematical Models Developed and Used in the Quantitative Decision-Making Process

	Model Representations		
System Elements	Criteria	System	Tradeoffs
System Output	System Effectiveness Model	Design Model Support Model	Maximum Effectiveness Tradeoff Model
System Input	System Economy Model	Cost Model	Maximum Economy Tradeoff Model
System Output/Input	System Worth Model	—	Maximum Worth Tradeoff Model

Figure 3.

improvements. Pictures, like the example, help one visualize what a complex mathematical model is calculating.

Computers. This information processing tool calculates and merges mathematical models with speed and accuracy. It is emphasized that computers do not make any decisions; they only expedite calculations which could not possibly be accomplished manually in the planning time available.

Payoff Matrices. Matrices can replace "cost effectiveness curves" which have been traditionally used in cost effectiveness studies. A matrix provides a convenient table which can show the values of all alternatives across all assumed contingencies. Further, a matrix can be evaluated by the mathematical expectation concept. A cost effectiveness curve can neither show the values of all alternatives across all contingencies, nor be evaluated to provide expected values and risks of alternatives.

Statistical Decision Theory. This tool reduces large size payoff matrices to a single column ranking of system alternatives, based upon a mathematical expectation or gaming criterion. It also eliminates undesirable system alternatives by rules of dominance.

Analytical Analyses

The quantitative decision-making process also involves synthesis and analysis which are performed in *specific* steps of the process. The analyses performed in each step and their purposes are briefly described at this point.

Definition. Three types of analyses are involved in the definition step. *Mission analysis* defines and relates the operational characteristic measurements that will be needed by a system to perform a specified mission. *Threat analysis* defines the effectiveness limits of each operational characteristic for each assumed threat scenario. *Economic analysis* defines the economy limits of the life cycle costs for each assumed budget ceiling.

Description. In describing a system, *synthesis* combines technical and support concepts to describe a base, or initial, conceptual system which may satisfy the performance requirement. *Innovation* changes the technical and support concepts to describe a change which may improve the performance, cost, and schedule of the base conceptual system.

Estimation. In the estimation step, *design analysis* develops a design model for each conceptual system to estimate its operational characteristic measurements for combinations of technical characteristic measurements, assuming that the logistical support is performed under ideal conditions. *Support analysis* develops a support model for conceptual system to estimate the operational ready rate for combinations of support element measurements, given the inherent availability and dependability of the system. *Cost analysis* develops a cost model to estimate the investment and operation cost, discounted to present value, for combinations of technical characteristics and support elements, given the prescribed operational quantity of systems and their operational lifetime. *Sensitivity analysis* estimates the relative effects of statistical and decision uncertainty of inputs upon the performance and cost outputs of the design, support, and cost models.

Tradeoff. In the tradeoff step of the quantitative decision-making process, *economy tradeoff analysis* optim-

Example Sketch Used To Explain What the Cost Model Does in Relationship with the Design and Support Models

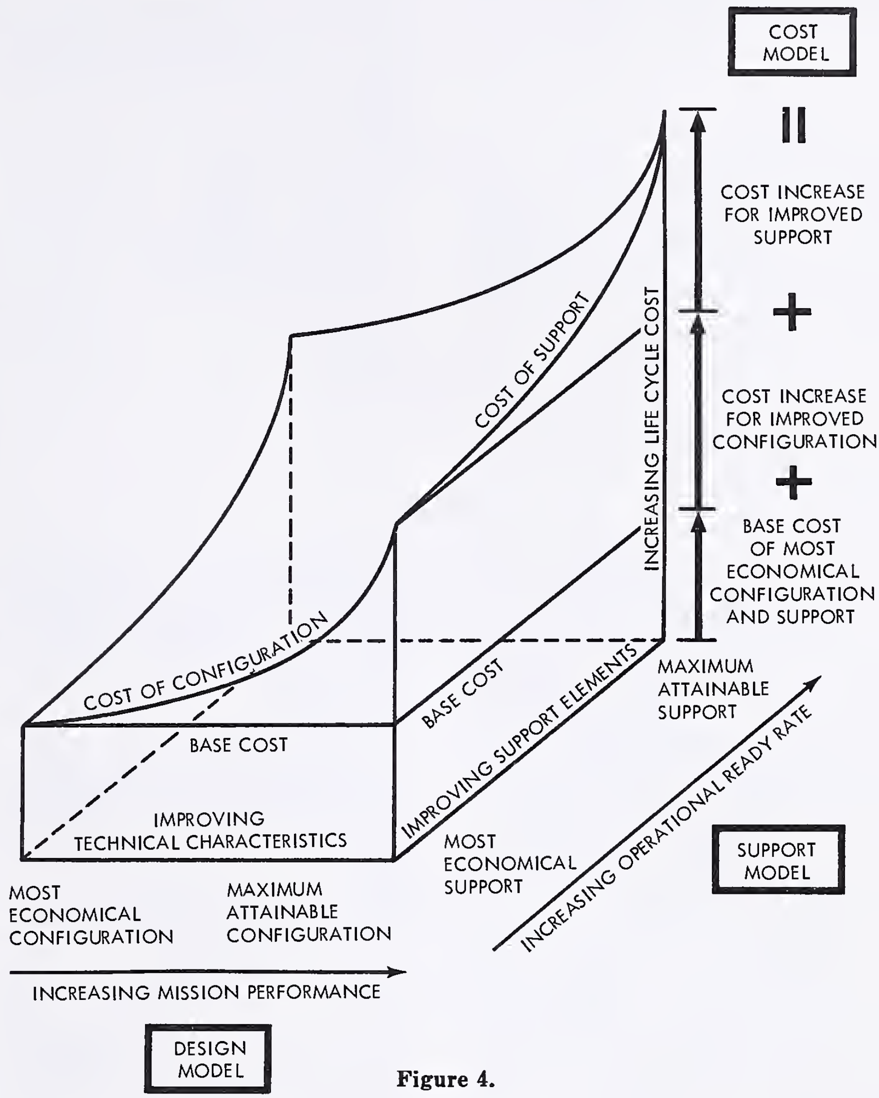


Figure 4.

Planning-Briefing-Guidance Cycle with Typical Cycle Schedule

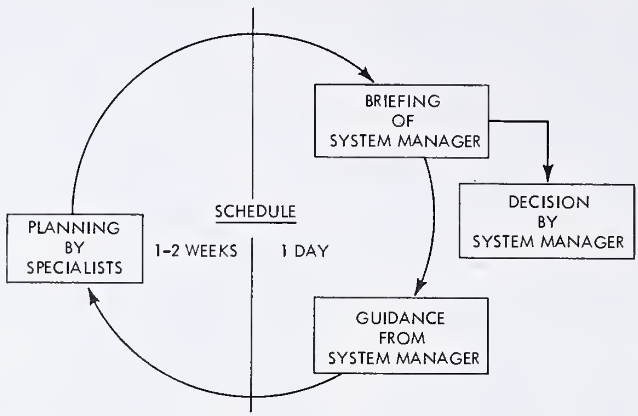


Figure 5.

izes the technical characteristic and support element measurements of each system, based upon the criterion of maximum system economy. *Effectiveness tradeoff analysis* optimizes the technical characteristic and support element measurements of each system based upon the criterion of maximum system effectiveness. *Worth tradeoff analysis* optimizes the technical characteristic and support element measurements, based upon the criterion of maximum system worth.

Comparison. In this step of the process, *concept contingency analysis* develops the worth matrix for each system to compare the changes in worth of innovations in its technical and support concepts. *Threat contingency analysis* develops the effectiveness matrix for each system to compare the changes in effectiveness for changes in threats. *Budget contingency analysis* develops the economy matrix for each system to compare changes in economy for changes in budgets.

Evaluation. Finally, in the evaluation step, *statistical analysis* ranks system alternatives by expected effectiveness and economy values. *Risk analysis* ranks system alternatives by expected effectiveness and economy risks.

A weapon system manager must know what, and where, analytical methods and tools are used in the steps of the quantitative decision-making process. He must also know the purpose of each method or tool to ensure that specialists contribute only that which is needed, when and where it is needed.

Interdisciplinary Skills

The combined effects of the increasing use of modern analytical methods for solving problems, and the proliferation of specialists in their use, has created the need for interdisciplinary skills to perform the steps of the quantitative decision-making process. No single individual has all the expertise required to perform these steps. With both the depth and breadth of knowledge continually expanding, individuals *must* specialize because they can absorb only so much knowledge in a lifetime.

A weapon systems planning team must, at least, consist of individuals for the following functional disciplines: military, systems engineering, financial analysis, cost analysis, statistics, and computer sciences. The team can be augmented in both depth and breadth, as necessary, by supporting government organization and defense contractor expertise.

The centralized interdisciplinary team approach is why system/project management has had a greater success in responding to complexity than any other management concept. System management brings unlike specialists together, to work together in managing complex and costly weapon systems. This team approach has also created the need for system managers who can coordinate and integrate specialists without necessarily being able to perform the jobs of specialists. One can, for example, manage a hospital and hire a brain surgeon without becoming one.

Planning-Briefing-Guidance

A planning-briefing-guidance cycle (Figure 5) is mandatory between the system manager and his systems planning team. The team, recycling through the contingency loop of the quantitative decision-making process, generates expected value and risk information for the system alternatives. After a period of one to two weeks of this planning activity, they stop to brief the system manager on the information generated to date. Based upon this interim value and risk information, the system manager provides guidance for their next period of planning. This recycling continues until a decision is made. It then begins all over again to generate information for the next system decision.

Time and resources are often limiting factors in this planning-briefing-

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guidance cycle. These constraints may compress, *but must not eliminate*, any steps of the quantitative decision-making process. If compression is necessary, then the process must concentrate on the most important operational characteristics, the most sensitive inputs to the design, support, and cost models, and the most likely threat and budget contingencies.

There are two major objectives in the planning-briefing-guidance cycle:

- It keeps the systems planning team oriented towards the objective of generating the information needed for system decisions. Without continuous guidance from the system manager, a specialist tends to direct his attention and efforts toward pursuit of his own individual interests and goals. If cooperation in combining knowledge, judgment, and skills fail, then the systems planning team is totally ineffective.
- It makes a system manager more and more knowledgeable about his system. Periodic briefings help him to get answers to questions anticipated during the formal justification to higher authority. Experience has shown that the system managers who have been most successful are those who have done their systems planning "homework" so as to be able to answer multifaceted questions asked by higher authority. If a system manager must continually return to seek answers to questions, then he loses his credibility, and he experiences serious delays in approval of the system plan.

Lieutenant Colonel Edward Shabsin, USAF, is a faculty member of the Defense Weapon Systems Management Center, Wright-Patterson AFB, Ohio. He teaches project management subjects in the senior resident course. Colonel Shabsin is a graduate of the University of Illinois and holds a masters degree in business administration from Indiana University.

Summary

The system management concept centralizes a system decision maker together with an interdisciplinary team in order to be more responsive to urgency than does any other management concept. This centralization accelerates the generation of information by specialists, the selection of a system plan by the system manager, and the approval of the system plan by higher authority.

In today's highly competitive environment for the allocation of national resources, no system can be approved without credible information about its expected value and risk. The quantitative decision-making process is what generates this expected value and risk information. System managers delegate the work of generating this information to an interdisciplinary planning team. These specialists apply their combined knowledge, experience, and skills to continually define and refine a system plan; they can also apply powerful analytical methods and information processing tools to reduce the uncertainty of estimates and assumptions. Under the guidance of the system manager, they continually generate information which helps him to be the most knowledgeable man in the world with respect to his system. This informed knowledge is the basis for logical system decisions, and the instrument for communicating the logic of those decisions to higher authority for approval.

It can be reasonably assumed that system management can be more successful if the system manager insists upon using a formal quantitative decision-making approach to generate expected value and risk information. The penalty for not using it may be frustration and delay of the approval of the system plan. The only penalty for using the formal quantitative decision-making process is that one has to learn it. One can learn by personal experience, or from the experience of others. This article is a brief summary of what has been learned about systems planning from the experience of practitioners in military system/project management.

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RFPs for A-X Plane Issued by Air Force

Requests for proposals (RFPs) for the competitive prototype development phase of the A-X specialized close air support aircraft have been issued to 12 companies by the Air Force.

The proposals are due in early August, with evaluation to be completed within approximately 75 days of receipt. Contracts with two companies for the competitive development phase, lasting approximately 26 months, would then follow.

RFPs were issued to: Beech Aircraft Corp., Wichita, Kan.; The Boeing Co., Seattle, Wash.; Fairchild Hiller Corp., Germantown, Md.; Grumman Aerospace Corp., Bethpage, N.Y.; LTV Aerospace, Inc., Dallas, Tex.; North American Rockwell Corp., El Segundo, Calif.; Textron Inc., Providence, R.I.; Cessna Aircraft Co., Wichita, Kan.; General Dynamics Corp., New York, N.Y.; Lockheed Aircraft Corp., Burbank, Calif.; McDonnell Douglas Corp., St. Louis, Mo.; and Northrop Corp., Beverly Hills, Calif.

Management of the program is provided by the Air Force Systems Command's A-X Systems Program Office, Aeronautical Systems Division, Wright-Patterson AFB, Ohio.

ABOUT PEOPLE

DEPARTMENT OF DEFENSE

The President has designated **Adm. Thomas H. Moorer**, USN, former Chief of Naval Operations, the Chairman of the Joint Chiefs of Staff. Adm. Moorer replaces **Gen. Earle G. Wheeler**, USA, who retires on July 2.

VAdm. Eli T. Reich, USN, former Dep. Comptroller of the Navy, has been assigned to the position of Dep. Asst. Secretary of Defense, Materiel, Office of the Asst. Secretary of Defense (Installations & Logistics).

RAdm. William R. Flanagan, USN, is now Dir., East Asia and Pacific Region Office, in the Office of the Asst. Secretary of Defense (International Security Affairs).

Brig. Gen. George H. Sylvester, USAF, has been designated Asst. Dir. (Operational Test and Evaluation) in the Office of the Dir., Defense Research & Engineering.

Donald R. Cotter, previously Dir. of Systems Planning, Sandia Laboratories, Albuquerque, N. M., is the new Dir., Overseas Defense Research Office (Project Agile), Advanced Research Projects Agency, Office of the Dir., Defense Research & Engineering. He replaces **Seymour J. Deitchman**, who has returned to the Institute for Defense Analysis.

Effective July 20, **Maj. Gen. Robert H. McCutcheon**, USAF, will become Dep. Dir. for Contract Administration Services, Defense Supply Agency. He succeeds **RAdm. Joseph L. Howard**, USN, whose new assignment is Commanding Officer, Naval Supply Center, Charleston, S.C.

Maj. Gen. Kenneth C. Dempster, USAF, is scheduled to assume the post of Asst. Dir., Plans, Programs & Systems, Defense Supply Agency, on July 15.

The new commander of the Defense Supply Agency's Defense Construction Supply Center, Columbus, Ohio, is **RAdm. Grover C. Heffner**, USN.

Other new assignments within the Defense Supply Agency include: **Capt. Jerome A. Rehberg**, USN, Dep. Commander, Defense Fuel Supply Center, Cameron Station, Alexandria, Va.; **Capt. Edward E. Renfro III**, USN, Commander, Defense Contract Administration Services Region, Chicago; and **Lt. Col. Harold W. Edwards**, USA, Chief, Defense Contract Administration Services Office, Wichita, Kan.

DEPARTMENT OF THE NAVY

Adm. Elmo R. Zumwalt Jr. has been designated Chief of Naval Operations, replacing **Adm. Thomas H. Moorer** who has become the new Chairman, Joint Chiefs of Staff. Replacing Adm. Zumwalt as Commander, Naval Forces Vietnam and Chief, Naval Advisory Group, U.S. Military Assistance Command, Vietnam, is **VAdm. Jerome H. King Jr.**

Adm. I. J. Galatin, Chief of Naval Materiel, retired on July 1. His replacement had not been announced at press time.

RAdm. Philip A. Beshany has been named Asst. Dep. Chief of Naval Operations (Fleet Operations & Readiness). Also, **RAdm. James B. Osburn** has assumed the position of Asst. Chief of Naval Operations (Safety).

Other new assignments in the Office of the Chief of Naval Operations are: **RAdm. William H. House**, Dir., Strike Warfare Div. and Nuclear Attack Carrier Program Coordinator; **RAdm. Lester E. Hubbell**, Dir., Antisubmarine Warfare and Ocean Surveillance Div.; **RAdm. Frank H. Price Jr.**, Dir., Ship Characteristics Div. and Chairman, Ship Characteristics Board; **RAdm. Donald C. Davis**, Dir., Aviation Programs Div.; and **RAdm. Robert B. Baldwin**, Dir., Aviation Plans & Requirements Div.

RAdm. John M. Barrett has been designated Dep. Chief of Naval Material (Programs & Financial Management).

RAdm. William T. Rapp has been named Dep. Commander, Naval Ship Systems Command for Plans, Programs & Financial Management (Comptroller), Washington, D.C.

New Commanding Officer, Naval Supply Center, Norfolk, Va., is **RAdm. Elton W. Sutherling**.

DEPARTMENT OF THE AIR FORCE

Gen. George S. Brown, Dep. Commander for Air Operations, Military Assistance Command, Vietnam, and Commander, 7th Air Force, Pacific Air Force, has been designated to become Commander, Air Force Systems Command, Washington, D.C., effective Sept. 1. He will succeed **Gen. James Ferguson** who is scheduled to retire on that date. **Gen. (selectee) Lucius D. Clay Jr.** has been named to assume Gen. Brown's position in Vietnam.

Lt. Gen. Austin J. Russell will become Asst. Vice Chief of Staff of the Air Force on Aug. 1. He will replace **Lt. Gen. John W. Carpenter III** who is retiring.

Lt. Gen. (selectee) James T. Stewart has been designated Commander, Aeronautical Systems Div., AFSC, Wright-Patterson, Ohio. The command has been upgraded because of increased scope of activity and responsibility. Gen. Stewart replaced **Maj. Gen. Lee V. Gossick** who, in turn, assumed Gen. Stewart's former position as Dep. Chief of Staff, Systems, Hq., Air Force Systems Command.

Maj. Gen. David V. Miller has become Dir. of Development & Acquisition, Office of Dep. Chief of Staff, Research & Development, Hq., USAF. He replaced **Maj. Gen. Thomas S. Jeffrey Jr.** who retired.

Maj. Gen. Sherman F. Martin will assume the position of Asst. Dep. Chief of Staff (Program & Resources), Hq., USAF, on Aug. 1. He

(Continued on page 12)

Security in Time-Shared ADP Environment

Thomas J. O'Brien

It is no secret that security, like many other disciplines in the modern business world, has not kept pace with the rapid technological developments in automatic data processing (ADP). Need for security guidance and security rules to ensure that information in the ADP environment is properly safeguarded is quite apparent to security people of both Government and industry. In recognition of this need, the Office of Industrial Security, in the Defense Supply Agency's Contract Administration Services (DCAS), has mounted an intensive effort to fill this guidance gap. The purpose of this article is to tell you what we have done, what we are doing, and what we contemplate.

ADP presents some unique security problems. Its capacity for handling huge volumes of data and its incomprehensible speed are the keystones of this security problem. When an espionage agent obtains possession of a Secret document, it is a fairly time-consuming process to photograph each page. On the other hand, surreptitious entry to an ADP system can result in a compromise of a great volume of classified information in a timespan that is measured in micro-, milli-, or nanoseconds.

At the outset, it is important to establish that machine language does not render information secure. If classified data is to be electrically transmitted over lines outside a controlled area to or from a computer, it must be encrypted in the same manner as teletype, voice, or other communications. Communication between computers, although not readily understandable, is not secure from a standpoint of safeguarding of classified information.

Identification of Hazards

As a first step in providing security guidance applicable to the ADP environment, it is necessary to identify the hazards. Although our list may not be all-inclusive, it is a significant first step in determining the security weaknesses of ADP. We have identified these security hazards.

Rapid development in machine sophistication, and the paralleling increase in the cost of such equipment, makes *time sharing* one of the most significant and economically desirable elements of ADP. Systems are currently being developed whereby a number of users, by means of remote terminals in their own offices, can avail themselves of the advantages of ADP without investing in their own systems.

Thus far, the state of the art of system design does not enable us to ensure that data entered into the system by one user cannot be accessed by another user. This is the heart of the problem. There are some software and hardware techniques which give a degree of security in this connection but, to date, none provide the degree of security necessary for safeguarding of classified information.

This problem has to be solved by engineers and scientists rather than by the security professional. Therefore, the matter was referred to the Director of Defense Research and Engineering who, in turn, established a study project within the Advanced Research Project Agency (ARPA). The purpose of the ARPA study project is to develop hardware and software criteria, and an appropriate inspection capability which would result in a secure time-shared system.

Pending development of a secure time-shared system, Change 2 to the Industrial Security Manual (ISM) for Safeguarding Classified Information (Attachment to DD Form 441) prohibits the use of classified information in a time-shared system. It is important to point out that a single contractor can use multi-programming or multi-processing techniques within his own facility, but different contractors cannot share an ADP system on a classified information basis.

A second hazard in the ADP envi-

Thomas J. O'Brien is Chief, Programs and Systems Division, Office of Industrial Security, Contract Administration Services of the Defense Supply Agency. Before joining the Defense Supply Agency, he served with the Office of Naval Intelligence in positions of increasing responsibility. Mr. O'Brien holds a B.S. degree in business administration from the Georgetown University School of Foreign Service, and a J.D. degree from Georgetown University School of Law.

ronment concerns *transmission.* This problem is not peculiar to ADP. The ISM provides that telephone or other electrical transmission can only be used by the contractor if a secure electrical transmission system is approved by the DOD contracting officer. This, of course, requires a cryptographic system. Such systems, adaptable to ADP, are available within the state of the art, but their supply is very limited and, in most instances, just not available. The contracting user agency of DOD can provide for a secure system where the highest priority can be established. Even in these cases, a lead time of 18 months or more is necessary.

ADP represents a unique *personnel security* problem because it is possible for individuals to gain access to information in the system without physical presence. The best example of this is the programmer. The programmer, who designs an unclassified program which is run simultaneously with a classified program, can gain access to the classified program. Therefore, it is necessary in designing a secure system to ensure that all programmers possess the appropriate security clearances, or that programs written by uncleared programmers do not run simultaneously with classified programs.

Maintenance personnel in ADP present a security problem. A maintenance man having access to the system can easily circumvent its built-in security features.

Another hazard, also unique to the ADP field, is called *accidental access.* This occurs in a freakish situation when data in one program unexplainably appears in the output of another program. This is called "bomb out" when a great deal of data from one program unexplainably appears in another. It is called "drift" when only some of the data finds its way from one program to another. In any event, it is a problem we must be aware of and guard against. Some computer people have told us that, theoretically, with program bounds and other software techniques this should not happen. However, the best evidence available to date indicates that it does.

Physical security is a problem area which presents special challenges in the ADP field. When classified material is "in process," or "on line," it is clear that the system must be controlled by means of area controls. The problem does not stop there. If access to an ADP system is not controlled, even during periods when classified data is not in process or on line, uncleared personnel having access to the system can neutralize the security measures built into the system. Therefore, a closed area should be established for an ADP system on which classified data is processed.

Interim Actions

With these hazards in mind, we have developed some interim guidance and standards by which an ADP system can be analyzed. It is emphasized that ADP security policy is still in the "research and development" stage. Guidance set forth herein must be considered as interim in nature at this time.

We have found that, as a general rule, ADP systems fall in one of four configurations.

Self-Contained: Exclusive Use. This is when the entire ADP system is within a controlled area and there is physical disconnect of all remote terminals whenever classified data is in process or on line (Figure 1). By establishing a "controlled computer area," we ensure that only cleared personnel have physical access to this system. This prevents access to uncleared maintenance personnel who might intentionally circumvent security elements built into the system.

It is also necessary to establish a means for dealing with the problem of program access without physical presence. The best solution would be to clear all programmers. A less desirable system would be to ensure that programs, written by uncleared programmers, are not processed simultaneously with classified programs.

ADP CONFIGURATIONS

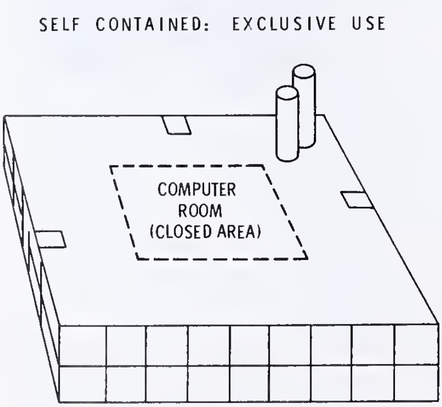


Figure 1.

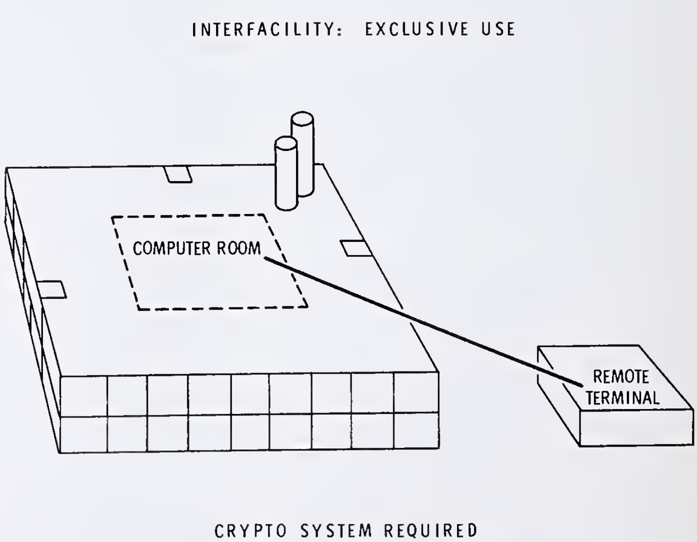


Figure 2.

It is extremely important in the design of exclusive use systems to carefully consider all security problems, and then design a security system promulgated by means of a Standard Practice Procedure (SPP) or an appendix thereto. This SPP should make necessary provision to ensure that any system modifications are first coordinated with the security officer. He must determine that the modification does not invalidate the security integrity of the system. The SPP must require that programs be written with specific instructions to clear the system of all residual classified information at the completion of classified runs. Moreover, a security system established in an SPP will assist the contractor in self-inspection and the cognizant security office in its recurring inspections.

Interfacility: Exclusive Use. The second major configuration, which we encounter, is a contractor who has established his own ADP system with remote terminals outside his facility at his own branch offices (Figure 2). In other words, access to the system is limited only to employees of the contractor. The only unique problem here is the transmission problem. Here the policy is clear. The contracting officer can approve a cryptographic system. In the absence of approved cryptographic systems, classified information cannot be put into the computer unless the remote terminals are physically disconnected.

Intra-facility: Exclusive Use. This is the ADP system totally within the contractor's facility or complex (Figure 3). It is designed with remote channels located at various points *within* the facility, but remote from the computer room. The fundamental problem here is the security of the wire that connects the remote terminals and the computer. In essence, this wire is like a classified document, *e.g.*, classified material is readily obtainable by anyone who has access to the wire. The best method to establish security in this kind of condition is the use of cryptographic equipment. As previously said, availability of this equipment is severely limited. However, there is an alternative. It is possible to establish an "in-depth physical security system" to protect transmission lines located within the facility. In each case, it is necessary for the cognizant security office to approve the system.

This in-depth physical security system will normally consist of several physical security factors which, taken together, give the degree of security needed. Some of the factors or security elements which might be built into such a system are:

- Physical security of the perimeter of the facility complex—the same concept envisioned by Footnote 9, paragraph 14, ISM.
- Hardened or buried cables.
- Surveillance of cables. This can be established in several ways, either alone or in combination.
- Physical security of repeater stations or other terminals within a facility. This would normally be accomplished by area controls, strong rooms, or similar physical security systems.

To assure necessary surveillance of cables, periodic guard patrols can be established. The guard on patrol must be fully knowledgeable of where the cable is and what it is, so that he would immediately detect any unauthorized personnel attempting access to the cable. Such a security system is strengthened by having cables, carrying classified information, run in plain sight of corridors rather than hidden under false ceilings. A second method of surveillance would be a pressurized cable with a monitoring system. Guards could be dispatched to any point of the cable where pressure is broken. Another element in this security chain may well be monitored idle code transmission. This method would enable a monitor to detect any unauthorized probing or attaching onto the line. Still another surveillance method would be monitoring by closed circuit television, established in combination with a guard system.

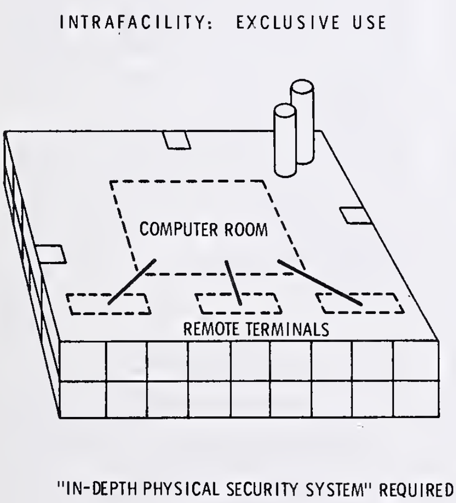


Figure 3.

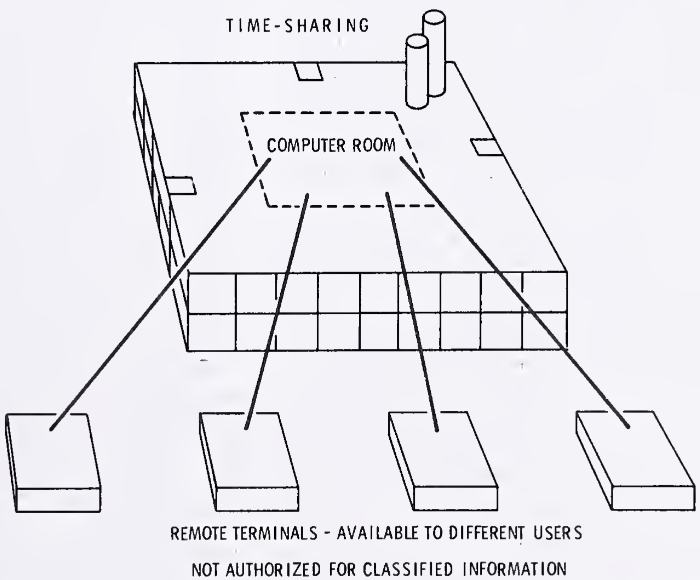


Figure 4.

Time Sharing. As discussed before, time sharing would involve the use of a single computer by more than one user (Figure 4). The policy here is clear—the ISM prohibits classified information in such a system. Let me point out again that we view this as interim policy. When the study now underway develops the necessary guidance and criteria, it is envisioned that time sharing under specified conditions will be authorized.

Regardless of the configurations of the ADP system, it is strongly suggested that every contractor utilizing ADP for classified data should have a security official assigned to the ADP operation. This security specialist should be thoroughly conversant with the ADP system, thereby enabling him to assess the security consequences of any proposed system changes or modifications. He would be responsible for monitoring the security aspects of the operation, and would be available for consultation on any security problems or questions.

ADP Subcontracting

Generally, the ADP subcontracting security question can be broken into two situations. First, there is the normal contractor-subcontractor relationship. When a prime contractor awards a subcontract which involves the use of ADP, the normal provisions of the ISM applicable to subcontracting apply.

The second situation is the use of service centers, service bureaus, etc. This involves a contractor using someone else's computer in a location other than his own plant to process a classified program. Change 2 to the ISM establishes the conditions under which this type of operation is permissible.

Basically, the requirements are that the computer be located in a cleared facility. Secondly, the user must obtain the exclusive use of the equipment while the classified program is being processed. A classified program cannot be processed if program or data, belonging to another user, is in process or on line. An operator employed by the service bureau may be used providing, of course, he is properly cleared. Third, the user must ensure the physical security of the system while his classified information is being processed. Finally, the user must obtain the prior approval of his cognizant security office.

The cognizant security office will ensure that the owner of the computer is, in fact, a cleared facility; that the user recognizes his responsibility to obtain exclusive use and provide for physical security. The cognizant security office will devote special attention and emphasis to ensure that the user has adequately provided for cleanup. In other words, it will ensure that appropriate steps will be taken to prevent any residue of classified material from remaining in the system.

In summary, I would like to briefly outline the action planned by the DCAS Office of Industrial Security to solve the ADP security problem.

First, Change 2 to the ISM provides some very important policy guidance. This is a big first step.

Second, in February 1969 cognizant security offices were provided specific guidance along the lines discussed in this article. In December 1969, this guidance was updated. Personnel of each cognizant security office are in a position to discuss your ADP problems and work with you to develop solutions to the ADP security problem.

Third, computer training has been provided for all representatives of the DCAS Office of Industrial Security. A pilot program, developed jointly by the DOD Computer Institute, the National Security Agency, the Defense Intelligence Agency, the Defense Communications Agency, as well as the Defense Supply Agency, was held in July 1969. This pilot program formed the basis for a security ADP training program held for all personnel of the office in the fall of 1969.

Fourth, and finally, we anticipate that an ADP Appendix to the ISM will be published in 1970.

It is recognized, of course, that there is still a long way to go. It is essential that standards and criteria be developed which will effectively safeguard classified information in a time-shared ADP environment. There is a need to increase the availability of cryptographic equipment with ADP interface.

The gulf in the ADP security state of the art has been significantly reduced. We are not there, but we are on the way.

About People

(Continued from page 8)

will replace Maj. Gen. **William B. Campbell** who is scheduled to become Chief, Army-Air Force Exchange Service, Dallas, Tex.

Brig. Gen. Edmund B. Edwards will replace **Brig. Gen. Richard L.** Ault as Dep. Dir. of Plans, Office of the Dep. Chief of Staff, Plans & Operations, Hq., USAF, on Aug. 1. Gen. Ault will retire.

Brig. Gen. (selectee) William R. Hayes has been assigned to Hq., USAF, as Asst. for Logistics Planning, Office of the Dep. Chief of Staff, Systems & Logistics.

New assignments within the Air Force Systems Command include: **Maj. Gen. Clifford J. Kronauer Jr.**, Dep. Chief of Staff, Operations, Hq., AFSC; **Brig. Gen. Robert A. Duffey**, Vice Commander, Space & Missile Systems Organization, Los Angeles, Calif.; **Maj. Gen. Louis L. Wilson, Jr.**, Commander, USAF Space & Missle Test Center, Vandenberg AFB, Calif.; **Brig. Gen. Harold F. Funsch**, Dep. Chief of Staff, Bioastronautics & Medicine, Hq., AFSC; **Brig. Gen. Herbert A. Lyon**, Asst. Dep. Chief of Staff, Systems, Hq., AFSC, with additional duty as Asst. for Southeast Asia; and **Brig. Gen. (selectee), Kenneth R. Chapman**, Dep. Chief of Staff, Development Plans, Hq., AFSC.

Maj. Gen. (selectee) Richard M. Hoban, has assumed command of the Air Force Logistics Command's Ogden Air Materiel Area, Hill AFB, Utah. His replacement as Vice Commander, San Antonio Air Materiel Area, Kelly AFB, Tex., is **Brig. Gen. (selectee) George Rhodes.**

Other assignments within the Air Force Logistics Command are: **Brig. Gen. William C. Fullilove**, Vice Command, Sacramento Air Materiel Area, McClellan AFB, Calif.; and **Col. Jacob B. Pompan**, Dir. of Procurement and Production, Warner-Robins Air Materiel Area, Robins AFB, Ga.

CORRECTION

Order number for Logistics Terms Glossary referred to in item on back cover, June issue *Bulletin*, is AD 700 066.

Economic Analysis of Navy Investments

Dick L. Jackson

The Department of the Navy has long recognized the need for using analytical techniques in the acquisition of investments. Among analytical techniques used in the past are systems analyses, cost effectiveness studies, cost tradeoff studies, benefit/cost analyses, analyses of repair versus replacement, lease versus buy, etc. Such studies have been conducted under a variety of instructions and requirements to assist in making sound management decisions.

These techniques are now covered under the provisions of SECNAV Instruction 7000.14 on economic analysis.

The principal objective of the Department of the Navy in its implementation of economic analysis is to assure that:

- Economic analysis techniques are used when they will contribute to sound decisions.
- Economic analyses are of such quality that they assist the decision maker.
- Manpower is not dissipated on economic analysis that is not productive.

Early Instruction

The Department of the Navy originally issued an instruction on economic analysis April 19, 1967. This Navy instruction implemented the DOD instruction of Dec. 19, 1966, which placed emphasis on commercial type investments where the costs and benefits were primary factors in the decision process. Results of these economic analyses were to be forwarded to the Navy Comptroller and, if approved, eventually to the Office of the Assistant Secretary of Defense (Comptroller) in support of budget and program change requests.

Since the FY 1969 budget, the first year covered by the original instruction, the Navy has prepared a large number of economic analyses covering shipyard modernization, replacement of machine tools at naval aircraft rework facilities, lease versus buy of automatic data processing equipment, and construction or modernization of other Navy facilities. Of these anlayses, 146 were forwarded to the Office of the Secretary of Defense in support of budgets.

These analyses had profitability indexes ranging from 1 to 79. In other words, the most cost efficient project would return $79 for each $1 invested. Although each of these projects would theoretically, over time, result in a net saving to the Defense Department, only projects in the area of shipyard modernization, machine tool replacement at naval aircraft rework facilities, and a small portion of military construction projects were funded in the President's budgets.

These results suggest that, in the decision process, fiscal constraints and urgent military requirements often supersede the best judgments based solely on economic analysis. No matter how high the payback ratio of a commercial type project, it has a limited chance of being funded unless it also satisfies an urgent military requirement. Often the decision maker will not or cannot trade current year dollars for paybacks tomorrow, because of the importance of obtaining performance or output today, or because of political or intangible considerations.

Revised DOD Instruction

In February 1969, the Office of the Secretary of Defense issued a revised and expanded instruction (DOD Instruction 7041.3, "Economic Analysis of Department of Defense Investments"). This instruction provides for standard terminology and consistent application of analytical tools in the decision-making process. The most significant change from the previous DOD instruction was the broadening of the scope to include:

- Proposed investments in new, improved, or expanded weapon systems, related military systems, or alternative force levels for such systems.
- Investment proposals in support of research projects to increase effectiveness and promote economy in military programs.

New Navy Instruction

On Jan. 30, 1970, the Secretary of the Navy issued SECNAVINST 7000.14, "Economic Analysis of the Department of the Navy Investments." The objectives of this instruction are to:

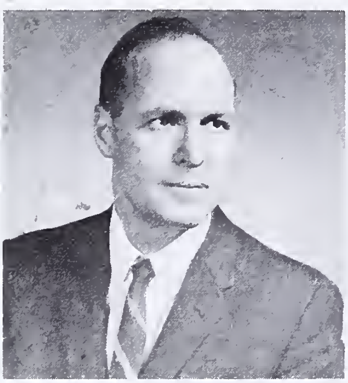
• Identify systematically the benefits and costs associated with resources requirements so that useful comparisons of alternative methods for accomplishing a task or mission can be made.

• Highlight the key variables and the assumptions on which investment decisions are based and allow evaluation of them.

• Evaluate alternative methods of financing investments.

• Compare the relative merits of various alternatives as an aid in selecting the best alternative.

The new SECNAV instruction places emphasis on eliminating redundancy in analyses by accepting, particularly in the area of research and development and the acquisition of major weapon systems, an analysis of alternatives considered in documents such as development concept papers, contract definition studies, cost effectiveness and force tradeoff studies. Where instructions currently exist covering these special areas of analyses, they are used. For example, concept formulation studies and contract definition studies for engineering and operations system development are to be conducted under the provision of SECNAV Instruction 3900.13A, "Initiation of Engineering and Operations Systems Development." This instruction requires analysis of alternative approaches. Although these instructions do not include discounting techniques, they do not rule out such techniques when they will contribute to accurate decisions.



Dick L. Jackson has been Director of the Financial Data Division, Office of the Navy Comptroller, since November 1969. He joined the Office of the Navy Comptroller in 1956 as Director of Progress Reports and Statistics Division, and later became Director of Program/Budget Systems and Cost Division. Mr. Jackson holds a bachelor's degree in mathematics and economics from Utah State Agricultural College, and a master's degree in statistics from the University of Minnesota.

SECNAV Instruction 7000.14 provides that discounting techniques should be used when they contribute to sound decisions. Further, a rate other than 10 percent may also be used if it can be shown that the discount rate is a basic factor in arriving at a good decision. Accordingly, the analyst may find it desirable to test at rates higher and lower than 10 percent before arriving at a judgment.

The new Navy instruction also allows managerial flexibility in determining when an economic analysis effort will be productive. This is considered essential as each year the Navy funds thousands of investments, and for nearly every one of these investments there are a number of alternative considerations which might be the subjects of formal economic analysis. Most well executed economic analyses are time consuming and expensive. If the Navy were to undertake a formal economic analysis every time a decision was required, it could result in a prohibitive workload for existing staffs.

The instruction also stresses the importance of quality economic analysis. A poor economic analysis is worse than no analysis at all. An economic analysis, no matter how poor, tends to produce an aura of professionalism that may cloud judgment.

The key to good economic analysis is consideration of all significant alternatives and parameters, and that accurate costs and benefits be associated with each of these parameters. Probably the most important role of an economic analysis is that it causes management to identify and evaluate the parameters of all alternatives involved. The identification of all significant parameters must be followed by the collection of accurate data and the application of proper techniques, if a good economic analysis is to be achieved. Further, it is important to guard against the inclination of an overly zealous manager to overstate benefits and understate costs.

The Navy instruction provides for a permanent advisory board, consisting of a professional from each of the following offices:

• Office of the Navy Comptroller—Chairman

• Office of the Chief of Naval Operations

• Headquarters, Marine Corps

• Office of Chief of Naval Material

• Office of Program Appraisal

Functions of this advisory board are to:

• Provide professional assistance to assure quality economic analysis.

• Interpret the meaning of the instruction and prepare supplemental guidance as may be required.

• Promote training and upgrading of personnel involved in preparing and reviewing economic analyses.

• Assure economic analysis effort when it will contribute to sound decisions.

• Assure that effort is not wasted on unproductive analyses.

Supplemental Instructions

Because of the varied nature of investments in the Navy, it will be necessary to issue supplemental guidance and instructions covering a number of areas. At this writing the Navy Facilities Engineering Command is preparing a detailed instruction covering military construction investments. This instruction will provide that an economic analysis be prepared for all investments where such an analysis would enhance evaluation of the project.

To distinguish between types of economic analyses, the Facilities Engineering Command instruction classifies economic analyses into primary and secondary categories. A *primary* economic analysis in the Facilities Engineering Command instruction is one employed to help determine whether an existing situation should change. For example, a determination as to the profitability of providing utility services at a pier and allowing the ship to shut down while berthed, versus operating equipment aboard ship to maintain utilities services. A

secondary economic analysis concerns itself with determining the most economical of several alternatives for satisfying a deficiency. An example would be "lease versus construct" analysis.

Potential Problems

Techniques and procedures for weapon systems. It appears that substantially greater effort should go into development of analytical techniques and procedures before economic analysis in the weapon systems area can be expected to achieve the desired objectives. For example, although extensive studies are conducted prior to making decisions on a new weapon system, it may be profitable to devote more attention to the costs of obtaining incremental performance at the frontier of technology. Often the next increment of performance is obtained only by crowding the development state of the art at inordinate costs.

Discounting. Some analysts are concerned about the use of a 10 percent discount rate for *all* economic analyses. Discounting serves two principle purposes in DOD:

- Comparison of investment of funds in the public sector with investment of funds in the private sector.
- Comparison of alternative investment cash flows within the Defense Department.

The latter use is most important to defense management. Concern about the 10 percent discount is based on three points. First, discounting often may not contribute appreciably to the decision-making process for many weapon systems and development studies when costs and benefits cannot be estimated with reasonable accuracy. Early estimates of research and development costs and/or benefits for new weapon systems often range substantially.

The second concern is that a discount rate, based on the average rate of return in the private sector, may not be the appropriate rate to apply to defense weapon systems. In the "real world," individual military investments are usually not funded in competition with the private sector. The military establishment is funded under a fiscal ceiling which rises and falls in relation to the conflict, or threat of conflict, existing at the time, and to other political pressures. Thus, in its own constrained world, DOD investments compete largely with each other.

As defense weapons are largely competing among themselves for funding from a single pot of money, there is logic for using a single discount rate for most defense investments, as provided in DOD Instruction 7041.3. Whatever the rate, its selection is a policy decision. However, this discount rate should be selected with care. High discount rates in general tend to favor continuing an old weapon system, rather than acquisition of a new weapon system, and vice versa. The rate of return may be the deciding factor in indicating which proposed investments are economically preferred.

Kenneth Boulding offered a little rhyme that highlights the influence of interest rates in connection with the water resource field:

The long term interest rate de-
termines any project's fate.
At 2 percent the case is clear
At 3, some sneaking doubts appear
At 4, it draws its final breath,
While 5 percent is certain death.

A third concern is about the applicability of a single discount rate for defense investments which are in competition with private sector investment. The single rate of 10 percent is based on the *average* economic opportunity rate of return on investments in the private sector. An average rate of return conceals wide variations. Therefore, economic analyses using an average rate of return may lead to biased comparisons.

This is most evident in those areas where the DOD investments are similar to investments in the private sector. Examples of such investments are the acquisition of office buildings, warehouses, and public housing. Alternatives in such cases are lease, lease-buy agreement, private construction, and government construction. In each of these areas, there is a private sector rate of return that is different from the average. Accordingly, it has been suggested that it may be more appropriate to use the rate of return of the specific part of the private sector, when analyzing these kinds of investments.

Risk and Uncertainty. The DOD instruction and SECNAV instruction provide that risk and uncertainty associated with investment proposals be set forth in narrative statements. No method has been established on how these narrative statements may be expressed as quantified data for analysis purposes. Obviously, in many studies these two factors may significantly affect the economic analysis.

Personnel. The quality of economic analyses is largely dependent on the staff personnel at the various management levels. As many economic analyses are complicated and require the application of special techniques and skills, many offices lack qualified personnel to perform well executed economic analyses. The Department of the Navy has partially offset this condition by establishing the permanent advisory board, which has as one of its responsibilities promotion of training and general upgrading of the analytical skill of Department of the Navy staffs.

Summary

Economic analysis is a valuable tool for identifying and evaluating the resource allocation consequences of investment proposals. However, it is important to caution that economic analyses only assist in the decision-making process. For example, a cost effectiveness comparison of procuring a new weapon system versus modernizing an old system may, because of the high initial capital outlay and a high discount rate, indicate the new weapon system is not the economical choice for the stated mission. However, the modernized weapon system may have no further growth potential, thus, leading to early obsolescence of the forces.

Military considerations must frequently override the economic results. In fact, it must be kept in mind that such analyses are only tools and are no guarantee that decisions will be better. Correct decision making depends on the quality of the analysis, the capability of the decision maker, future events, and luck.

Quality economic analysis will result in economic analysis decisions being based on better information. This will allow more effective use of the nation's resources.

Defense Research and the University

Dr. William J. Price

In the past three decades, an effective and important working relationship between the Defense Department and the university research community has come into existence. From this close partnership has developed a vigorous, sustained interchange of ideas, talented manpower, and mutually supportive activity.

For DOD it means direct and continuing access to scientific training, accomplishment and progress, accompanied by the personal attention to defense problems of some of the best scientific and technological talent in the country. Strong interactions have resulted between science and technology, with benefits both for the defense establishment, industry, and other sectors of the domestic economy.

For universities this means continuing support for basic and applied research as well as exploratory development, and a direct relationship between them and the technological needs of national defense. Increasingly, we see these needs straining the limits of current technology.

For these reasons the DOD-university research program, and that of the other Federal mission-oriented agencies, must be continually encouraged and strengthened. This does not preclude shifting of funding levels somewhat in times of austerity, but the basic relationship remains productive and must be effectively maintained.

World War II to Today

Defense Department research support programs began, in response to national needs during World War II, with the Office of Scientific Research and Development under Dr. Vannevar Bush. The Navy opened its Office of Naval Research in 1947, and the Army and the Air Force soon followed with corresponding offices. As the culmination of long planning, the National Science Foundation (NSF) came into being in 1951 for the support of university research and education in the sciences. NSF research programs were the first to support non-mission-oriented Federal basic research. Other agencies of the Government were also supporting university research along the lines of their agency responsibilities. These included the National Institutes of Health, the Office of Education, the Department of Agriculture (long-time research programs), and later the National Aeronautics and Space Administration. This development enabled the support of university research by a number of different sources of the Federal Government, a concept that has helped to ensure support for a wide variety of research of high quality.

Total Federal obligations for FY 1970 for research and development are estimated at about $16 billion. Of this amount, less than 10 percent, or $1.4 billion, goes to academic institutions for performance of research and development (Figure 1). Another $767 million goes to university-affiliated Federally Funded Research and Development Centers (FFRDC). About 16 percent of the total for universities comes from DOD, or about $223 million. DOD also provides about $150 million for its Federal Contract Research Centers (FCRC).

The DOD portion of support to university research and development about equals that of the National Science Foundation. For perspective, it must be realized that the figure for NSF represents all basic research—none for applied, and none for development, the costly item. NSF has another $200 million for science education, university development, national research centers, and related programs.

Over the past decade, total Federal support of university research and development has risen far faster than DOD's portion. DOD support has been fairly stable. The important point is that DOD's percentage decrease reflects the growing dependence of universities upon other sources of support. This fact indicates the urgency of making more funds for university research available through agencies such as the National Science Foundation. Undoubtedly this trend will continue and even accelerate as more funds for research become available. In 1952, the DOD share of total Federal university support was about half. In 1968, it was about 15 percent. However, most of the growth in Federal funds in recent years has been for fields outside the physical, mathematical, and engineering sciences. DOD still supports perhaps as much as one-half of the Federal total in these areas.

Current DOD Programs

In a letter to Senator Mike Mansfield in December 1969, Dr. John S. Foster Jr., Director of Defense Research and Engineering, described defense basic and applied research as

having three major functions: "to solve recognized technological problems which arise from both short and long range military operational requirements; to minimize the possibility of technological surprise; and, as an automatic byproduct of the first two functions, to contribute to the national technical base from which all agencies of the Government, including Defense, ultimately draw their scientific ideas and skilled manpower. . . ."

The DOD research program is in 13 scientific disciplines. Universities receive about 40 percent of these research funds, in-house efforts absorb about 40 percent, and all others account for about 20 percent. In addition, the research program includes Project Themis, conceived and directed to a large degree by the Directorate of Defense Research and Engineering, and set up to establish new centers of university expertise in selected areas related to defense problems.

DOD-University Mutual Interests

One of the strengths of the DOD-university relationship is that it is built upon mutual understanding and respect for its common interests. The principal function of a university is education of the young men and women needed by society. Knowledge must be transferred to them so that they may both use knowledge and further develop knowledge. The university is clearly the principal agent of society for supplying education. Concomitant with this role is the university role of scholarly research. Research leads to the knowledge and understanding of various phenomena which form the content of science and the foundation of many of the innovations taking place in society.

Universities have a vital role in the problems faced by society. They must emphasize studies and activities which help to assure the future of society, as contrasted with the short term problems which are the primary work of Government and other non-university activities. Whatever their specific contributions toward solution of problems, this involvement is important in helping assure the relevance of university education, and in assisting in communication between those primarily concerned with generating new knowledge and those using it. This function is particularly important to the engineering and other professional schools, but is also of growing concern to the schools of arts and sciences.

Research support at universities by DOD and other mission agencies is in concert with these university roles. It makes possible a plurality of sources of support for the university researcher, and reduces the possibility that promising research will be overlooked. It also makes available strong continuing support and interest in particular fields of science and areas of investigation judged to be of interest to both DOD and university scientists. Additionally, support through mission-oriented agencies enables many investigators to relate science, technology, and society in a direct manner often not available to the academic scientist. Many researchers are at their best when confronted with a combination of a desire to know and a need to know. This combination can be a doubly motivating force. Finally, mission-oriented support is important in obtaining adequate funds for university research and graduate education. Adequate research support for university work probably can be attained by appropriations only with a general understanding of why and how the research is important. Funding by a mission-oriented agency often helps explain this need.

Many university professors, in their concern to assure the future of society, desire especially to work on the problems of national security, and particularly on the long range ones.

Federal Obligations for University Research and Development, FY 1970, Estimated By Selected Agencies

($ in Millions)

Total		$1,418
Total DOD		223
Army	30	
Navy	77	
Air Force	70	
Other DOD agencies	46	
Health, Education & Welfare		617
National Science Foundation		225
Atomic Energy Commission		100
NASA		110
Agriculture		70
All others		73

Note: Excludes FCRCs
Source: Bureau of the Budget Special Analysis Q

Figure 1.

Academic research can contribute to their solutions in essential ways. University staff members also help provide a bridge between the scientific community with its potentially relevant knowledge and those having need for this knowledge in the applied and development activities necessary for national security.

Thus, by supporting university research in areas judged to be particularly relevant for DOD needs, the defense posture is strengthened by making it possible for some of the country's outstanding scientists and their students to work in areas likely to have great importance to national security. The support assures that both scientific knowledge and educated persons will be available in the scientific fields expected to be most important. In addition, a bridge is maintained between DOD and the universities with many resulting benefits to DOD, such as the availability of expert consultants.

The DOD administration of the university support programs has been especially designed to assure that mutual interests are optimized. For example, since all university basic research sponsored by the DOD is now unclassified, no requirement exists for prior review. Completely open publication is required, either in scientific literature or in the form of technical reports. Formerly, some projects at universities were classified, mainly to give researchers access to information developed under classified projects, but ways have been found to permit access as necessary to classified research information. The security classification question does arise in exploratory development in certain cases and, occasionally, in the application of some of the knowledge gained in basic research. In these instances, no attempt is made to encourage university administrators or faculty members to undertake, or to continue classified research projects in opposition to university policy. All DOD-university contracts are with the institution itself, not with an individual researcher.

Dr. William J. Price is Executive Director of the Air Force Office of Scientific Research, Washington, D.C. Prior to this, he was Chief Scientist, Aerospace Research Laboratories, Air Force Institute of Technology, Wright-Patterson AFB, Ohio. Dr. Price holds a bachelors degree from Denison University, Granville, Ohio, and a masters and Ph.D. (physics) from Rensselaer Polytechnic Institute, Troy, N.Y.

Administration of DOD Support

There are more similarities than differences between the research program managements of the Army, Navy, Air Force, Advanced Research Projects Agency, and other defense agencies. The programs are based primarily on proposals initiated by the university or industry researcher, designated as unsolicited proposals. The prospective principal investigator submits a proposal through his institution in widely circulated fields of active interest indicated by the various DOD agencies. Through this mechanism, a researcher can develop a proposed attack on a scientific problem of his own choosing. Typically, this is phenomena-oriented research in an area in which the investigator has considerable background. He estimates the duration of his proposed effort, the level of effort in terms of his own and his assistant's time, and the equipment involved. This proposal is then forwarded to an appropriate agency.

The researcher's choice of agency to which to send his proposal implies that the DOD agency has done a good job in conveying information to the scientific community on the kinds of research it will support and, particularly, the kinds and nature of the problems it is most concerned with. Before submission, the investigator is encouraged to discuss his proposed work with the staff of the agency to ensure its compatibility with the agency's research program.

The fundamental selection criteria are headed first by the relevance of the research to agency mission and research program needs. Selection of research areas by the DOD agency is a separate topic to be discussed later.

Among the selection criteria for research proposals are scientific quality of the work in terms of current scientific problems. Is the work proposed at the cutting edge of advancing knowledge? In many instances, proposals are submitted to evaluation panels to gain a wider base of opinion of their scientific excellence. From these evaluations and other comparisons, we know that we are getting proposals which rank with the best of any Federal agency. Other criteria are the qualifications and experience of the research staff, the adequacy of facilities, and the reasonableness of costs. Cost is a matter of negotiation, and of willingness of the proposing institution to cost-share some of the research effort. In this way, DOD receives a high rate of return on its research investment.

Interfacing with Users

The key to the effectiveness of the DOD research program is communication. The DOD agency sponsoring the research acts as an interface between the researcher and the user. Hence, staff members of DOD research agencies must have the mission, the experience, and the techniques required to identify DOD problem areas, and to translate them into scientific research opportunities. This interface also functions the other way, *i.e.*, to translate scientific knowledge and understanding into results usable by DOD development laboratories or defense contractors, either industrial or nonprofit.

By properly selecting research activities to support, DOD can help assure the availability of especially relevant knowledge when needed; and also assure communication between the scientific community having the knowledge and the technological community having potential use for the knowledge. This latter activity we designate as coupling.

The greatest challenge that research managers face is the selection

of areas of research. Selection involves the distribution of research resources among the many possible fields and subfields of science. It is part of the central problem faced in the U.S. Federal science policy and in the science policies of most countries. We need the ability to select what society most needs from all the projects that scientists would like to do.

The Air Force is currently giving particular attention to research planning, establishing approximately 40 research planning objectives in the 7 broad areas listed in Figure 2. In each of these areas, we are determining the scientific knowledge needed both to support technical planning objectives of the Air Force development organizations, and to create new technological opportunities. The latter research requirements are more in the nature of scientific opportunities which have some potential for creating new technological fields for future consideration.

We are relating our scientific program to these research planning objectives in interdisciplinary groupings. Groups of work units for appropriate engineering sciences and more fundamental sciences appear to support specific problem areas. As a thorough analysis is made of the needs for science, including that science with potential for creating substantially unknown technological opportunities, management information is obtained which is useful in deciding program distribution. This type of planning requires careful management for its accomplishment, while at the same time assuring the adequate support of more fundamental work so important to our future technological base.

There are many effective mechanisms for coupling science and technology. In his communication role, the DOD scientist maintains his contacts with the DOD applied research and exploratory development community. Many personal contacts are made by visits, correspondence, special reports, program reviews, and participation in joint task groups.

University scientists, who have DOD support, are able to participate directly in DOD activities in many ways. Among these are consulting visits to DOD installations where they may contribute solutions to pinpointed problems. They also serve as members of ad hoc groups to study feasibility of various exploratory development programs; on state-of-the-art reviews, either oral or written; in special purpose symposia which are specifically designed to bring technologists and scientists together; on special lecture tours; in performance of feasibility studies on research phenomena to put them into more readily usable forms; and in direct consultation with aerospace industries. Many scientists find significant satisfaction and stimulation as they make these important, direct contributions to the defense establishment, and to the accumulation of basic knowledge.

Some grants and contracts may be thought of as primarily designed to improve our communication with a particularly fast growing field of science. Many times our resources do not permit us to be pivotal sources of support. But key grants and contracts can give us the insight and first hand knowledge of the field from one or more leaders in that line of research who do keep current. We also sponsor scientific conferences and symposia designed to foster communication within a field and to give us, as DOD project managers, valuable overviews.

Conclusions

The continuance of a strong and effective DOD-university relationship based on cooperation is of the highest importance. There is good reason to believe that the profound nature of the mutual interests will demand it. However, potential misunderstanding in some parts of the Congress, the universities, and DOD make it necessary to continue to manage the DOD research program in a way that will ensure maximum effectiveness and credibility.

Recent Congressional legislation provides an example of special need for management emphasis. As a result of Section 203 of the FY 1970 Military Procurement Authorization Act, we are required to document that the research supported by DOD has "a direct and apparent relationship to a specific military function or operation." The impact of Section 203 to date has been to cause realignment of some programs, but it is too soon to tell what the requirement will do in terms of long term research goals. The net effect can be to strengthen the impact of the overall program, but careful management will be necessary to accomplish this without permitting the shorter range projects, with the more readily recognizable payoffs, to squeeze out the more basic research essential for the future.

DOD is doubly challenged to implement Section 203 while, at the same time, it further develops cooperation based on mutual DOD-university interests. The policy, currently being evolved concerning the implementation of Section 203 and future restrictions on the use of military appropriations, is crucial to the long term continuation of the DOD-university programs.

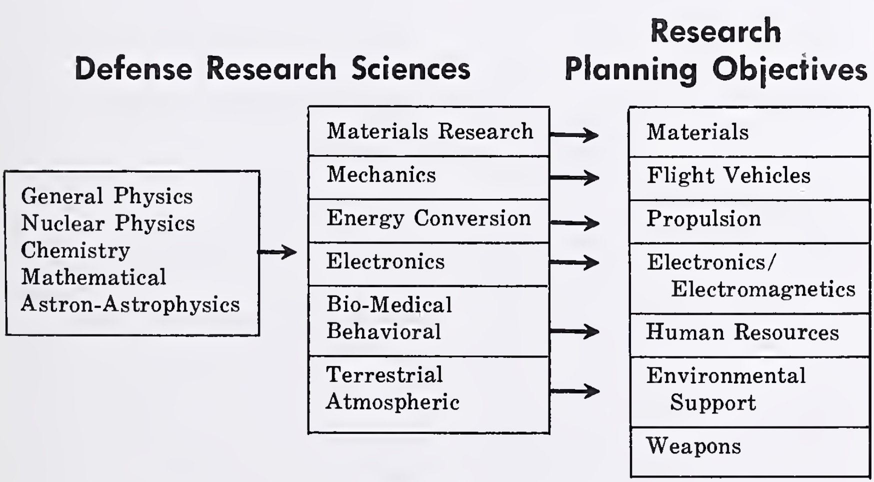


Figure 2.

Challenging the Hawk

Colonel Edwin M. Rhoads, USA

A blinding wall of snow crystals driven by gale force subzero winds across a forbidding land of spruce forests, glacier stripped mountains, multichanneled rivers and rocky open stretches deterred even the hardiest of the aborigine children of nature roaming the northern lands. "The Hawk," as these winds were referred to by the Indians of central Alaska, is challenged continually by equally hardy members of today's U.S. Army. The conditions of climate and terrain encountered at Fort Greely, Alaska, home of the Army's Arctic Test Center and Northern Warfare Training Center, are representative of those occurring throughout a large portion of the earth's surface known as the Area of Northern Operations. The testing of equipment to permit our Army to function effectively anywhere within this northern region is the primary mission of the U.S. Army Arctic Test Center, a subordinate agency of the U.S. Army Material Command's Test and Evaluation Command.

The Area of Northern Operations is the area in the Northern Hemisphere above the temperate zone, where environmental conditions require the application of special techniques and equipment for the conduct of military operations.

During winter, subzero temperatures are prevalent, and exceed —65 degrees F. in the interior of the continental regions and Greenland. Most of the area is covered with snow for three to seven months of the year or more, the snow melting away completely during the summer months. The Greenland icecap, the northern islands, and the high mountain regions have a permanent snow cover. The average snow depth, away from areas of local drifting, is 30 inches, with the greatest annual accumulation occurring between 40 degrees and 60 degrees N. latitude. Inland waterways and the ground surface are frozen from two to nine months of the year. The larger lakes in the southern area are blocked with ice even when not completely frozen over. The occurrence of water fog, ice fog, and blowing snow, added to the long duration of darkness in the higher latitudes, results in a considerable reduction in visibility throughout the winter months. Albeit, reflection by the snow of light from the moon, stars and auroral displays in clear weather greatly enhances night observation.

In summer, the presence of permafrost beneath the thawed surface soil prevents absorption and drainage of melting snow and ice. The result is extensive bogs and marshy areas. These, together with the profusion of lakes, streams and rivers, present formidable barriers to overland movements. They harass the establishment of fixed installations. Twenty-four-hour daylight throughout most of the area, even south of the midnight sun, poses unique problems, as do the myriads of insects during their brief but active season.

These seasonal factors, affecting the conduct of military operations, are compounded by remoteness and long distances, scanty population, and dearth of developed areas, roads and rail nets. Electromagnetic disturbances are aggravated in the polar regions, which often play havoc with radio communications and electronic equipment.

The topographic obstacles to movement of combat forces and logistics support, overland and through the air, are no greater in the northlands than in Southeast Asia. Snow and ice present problems in traction, but offset this detriment by providing an ideal running surface for skis and sleds. Frozen ground is a much better medium for heavy vehicles and aircraft than rice paddies and the summer muskeg swamps of the north. Frozen lakes and rivers are no longer barriers but facilitate movement, although deceptive ice conditions can trap the unwary. The most unhospitable regions of the earth, including both poles and the highest mountains, have been traversed by vehicles, aircraft, or on foot, and technology ex-

ists for the development of military equipment to meet the Army's operational performance requirements, wherever it must fight.

Many Problems Still Exist

Although much of the hostile environment of the north has been conquered, the Hawk's continuing challenge to the developers of military equipment is reliability, dependability, and the compatibility of that equipment with the soldier who must use it.

Sophistication and complexity are inevitable in the achievement of the increased combat power necessary on the modern battlefield, but complex systems often fail drastically under the harsh conditions of low temperatures and restricted visibility. The basic design of equipment intended for sole use in an extreme environment, or a worldwide item which will be a major element of equipment for the military force in that environment, must accommodate the conditions of that environment and the soldier-user. The obstacles must be overcome either inherently or by appropriate kits, *the compatibility of which must be addressed initially in the development process.*

As climatic factors prescribe the Area of Northern Operations, so do they have a primary impact on both the tools of military operations and the soldiers who use them. Extreme cold affects materials and components of military equipment in a number of ways. When subjected to temperatures below —25 degrees F., many types of metals, rubbers and plastics lose their normal properties of strength and resilience, making them unsuitable for their intended purpose. When performance characteristics of materials used in components of military equipment are altered by environmental conditions, the performance of the equipment as a whole is jeopardized. Some of the most frequent defects are more effectively shown than described. There are rubber compounds, plastics and metal alloys suitable for cold weather use, many of which have evolved as a result of our outer space program. The solution is proper selection of materials during a design process that actively considers operations in the northern climates.

Lubricants congeal at low temperatures, losing their lubricating qualities and offering physical resistance to moving parts on military machinery. The substitution of synthetic lubricants for natural petroleum products has been a major advance toward the solution of this problem. The synthetics retain their liquid properties from the extreme cold temperatures encountered to +40 degrees F., eliminating the necessity for frequent oil changes due to temperature fluctuations during the winter months.

The effects of cold on batteries, though well known, still present a serious problem for which no suitable solutions have been offered. Batteries lose their capability to deliver current in direct proportion to decrease in temperature. At —50 degrees F., a fully charged battery shows normal voltage on the voltmeter, but current discharge is nil. Once cold, a storage battery will not accept the charging current rapidly and completely during vehicle operation, unless it is warmed to +40 degrees F. Until a breakthrough is made in the development of small silent power sources, we must stick to electrochemical cells and provide a dependable source of heat to maintain proper operating temperatures.

One of the most nagging problems which has plagued winter military operations is the lack of suitable heaters and winterization kits. Not one of the vehicle heaters currently in the Army inventory has met Army performance requirements, necessitating waivers to get them into the field. Winterization kits all too often are added to vehicles as an afterthought, rather than engineered during the design of the vehicle. Often, reliability of the heaters themselves is considerably less than desired, resulting in frequent failures.

This problem affects all aspects of mobile operations: vehicle starting, crew comfort and even survival during mission operation, standby operation, and maintaining battery power. In addition to improved ruggedness and reliability, a real advance in the design of vehicle heaters would be the provision of standby, low heat operations without drawing on the vehicle battery.

Another persistent and major problem in the northern winter is equipment maintenance. Not only must simplicity and ease of maintenance be the golden rule in designing hardware for the north, but mechanics need portable and easily erected maintenance shelters, safe and dependable heating and lighting, and adequate tools. Normal servicing and minor repair jobs, accomplished in a minimum of time in warm weather, can be excruciating, even impossible, under severe windchill conditions without these additional measures.

Testing in Actual Environment

During the design and engineering development of hardware, exposure to simulated extreme environmental conditions is necessary to ensure that the materials, basic design and components of the item will perform. Proof of the pudding is in the eating, however, and thorough testing in the actual environment is essential to determine the feasibility of test rigs, soundness of engineering, and suitability of the end items in the hands of troops.

Located 105 miles southeast of Fairbanks, Alaska, and 175 miles south of the Arctic Circle, the nearly 1 million acres of the Fort Greely military reservation provide the setting for the conduct of northern area environmental tests. This is the U.S. Army Arctic Test Center, equipped for engineering and service testing of all classes of Army equipment.

Test facilities at the center include instrumented firing ranges for air defense and surface missiles up to 45 kilometers in range, artillery, tanks, mortars and small arms; a 600-acre drop zone; over 100 miles of vehicle road and cross-country courses; a field laboratory for testing vehicle winterization kits and cold starting; and a chemical test area. Instrumentation, including high speed photography, is on hand for technical testing of vehicle and aircraft performance, weapons functioning, communications equipment, chemical items, fuels and lubricants, and water purification systems. Recently a modern instrument calibration facility has been installed.

Because the center has no in-house capability for instrumented testing of rockets, missiles, electronic warfare, or surveillance equipment, the responsible Army developing or processing agency provides the necessary instrumentation and personnel for these tests.

During the past two winters (FY 1969 and FY 1970), more than 100 test programs were successfully conducted.

Some Succeed, Some Fail

A number of items tested are returned to the center for further testing, after initial evaluations have detected deficiencies in design, winterization and kit suitability, and reliability.

The winterization kit for the M88 recovery vehicle was retested in FY 1969 for the sixth time, and again was declared unsuitable for U.S. Army use in the Arctic. The problem was clearly design in nature. The vehicle is equipped with one heater to supply heat to both engine and crew compartments. In the words of the test officer, "One or the other was always cold."

Exhaust from an auxiliary engine, the "Little Joe," mounted on the M88 was directed by design into the engine compartment to assist in warming the engine. However, the exhaust fumes contained moisture which froze at low temperature. A barrier of ice formed on the engine which prevented warming affect from the exhaust, and added to the load of the overworked heater.

The M551 Sheridan airborne/assault vehicle, also tested in FY 1969, had a winterization kit which was adequate in design. It, too, failed the test at the center because the heaters were unreliable.

In every vehicle tested at the center

during both FY 1969 and FY 1970, heater reliability was a major source of frustration. Heater deficiencies contributed to the unsuitability of winterization kit systems of both adequate and inadequate design.

The CH–54A Flying Crane helicopter was tested at the center during FY 1969 and, although some deficiencies were found, these were corrected and the aircraft was declared suitable for use in the arctic. The Crane performed several actual recovery missions of armored vehicles, and was versatile, reliable, and adaptable to use in extremely cold climates. Today, the Crane is being used successfully in civilian operations in the North Slope oil fields in Alaska above the Arctic Circle.

The center tested the Canadian M571 articulated vehicle, and judged it suitable for U.S. Army use in the Arctic after several easily correctable deficiencies were eliminated. The articulation principle contributed to the outstanding mobility of the vehicle. It was extremely reliable in cold starting. It was used successfully in a variety of roles during the winter, from pulling skiers to hauling equipment and personnel. The only winterization kit problem, other than heater reliability, was the common problem of supplying warmth to batteries. Test personnel redirected some of the hot air from the defrosters to the battery compartment, solving the problem.

During the FY 1970 season, the M35A2C 2½-ton truck was evaluated. Test personnel rerouted the flow of coolant through the engine compartment to make cold starting possible. As designed by the developer, the coolant flowed from the coolant heater to the engine and then to the battery compartment. By the time the coolant reached the batteries, it was too cold to provide the required warmth to enable the batteries to retain their charge. The test group reversed the flow, supplying heat to the batteries first. The coolant reaching the engine was still warm enough to heat the engine adequately.

The 809 series 5-ton trucks tested during FY 1970 were equipped with commercial diesel engines, an off-the-shelf buy by the Army. The engine was highly satisfactory, but heat to the batteries was not adequate, and the heaters were unreliable. Again, the unsuitability of the winterization kit was detrimental to the successful test of the vehicle.

Lightweight loadcarrying equipment for infantry troops, tested this year, lacked durability. It was, therefore, found to be unsuitable although the basic concept is sound. Troops involved in the evaluation had continual problems with "D" rings bending and tearing out under the combat loads. Also, the sizing of the equipment was not adequate, and could not be worn by large men wearing the arctic winter uniform.

Components of the Army Area Communication System were tested at the center during FY 1970, and were functionally suitable for arctic use. Frequency stabilization was good, and the radios were capable of continuous operation for up to 72 hours. Several problems were encountered with small components, which operators had difficulty handling while wearing protective handgear. The shelter heaters supplied for the test were not adequate for the Arctic.

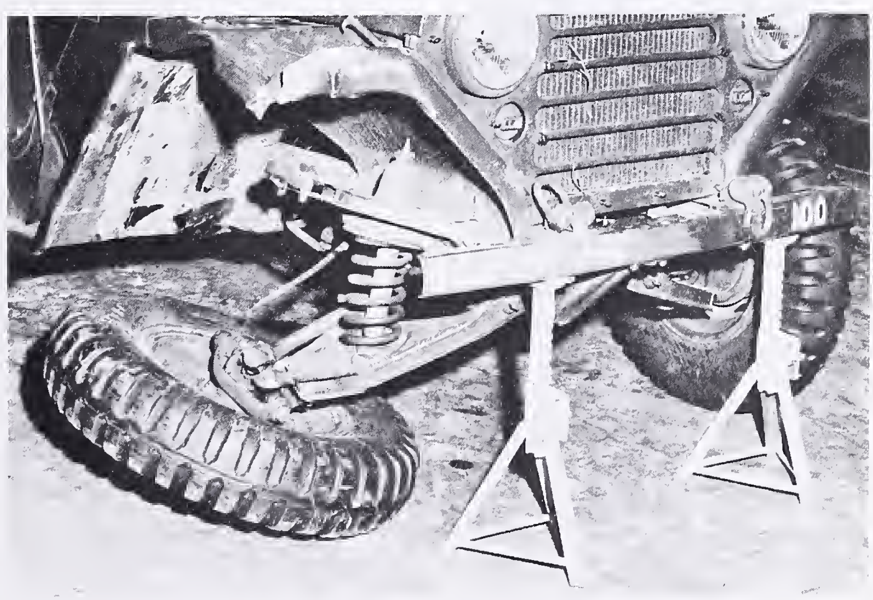
Several rocket and missile systems were tested by the center during FY 1970. They displayed common problems related to rocket motor functioning at low temperatures. The rocket fuel burned more slowly than was expected, and solid propellants would chip and clog the propulsion parts in the motors, resulting in malfunction.

Considering the Human Factor

During the FY 1970 test season, test officers reported numerous human factor engineering failures. Most required actions which could not be performed by operators wearing adequate protective handgear. Common faults were zippers without extensions for gripping with mittens, removable pins which could be grasped only with bare hands, and wing nuts too small for handling with gloves.

Other obvious failures were reported during the test of the Light Observation Helicopter, OH58A, during FY 1970. The drains for the transmission and freewheeling as-

Equipment must be designed for ease of use by a soldier wearing bulky arctic mittens and other protective gear (far left). When subjected to temperatures below —25 degrees F., many type of metals and rubbers lose their normal properties of strength and resilience. Rubber tires can shatter (left) and metal vehicle components can become brittle.



sembly cannot be serviced by a crewman wearing protective handgear. Once opened, the drains spill fluid onto the engine deck. Seepage soon leads to saturation of the passenger's seat inside the helicopter.

The overtemp circuit breaker for the helicopter heater is located behind the soundproofing material in the passenger's compartment. To reset the circuit breaker, the soundproofing material must be removed. The circuit breaker could easily be positioned on the regular circuit breaker panel.

The control box for the same heater is directly behind the pilot's head, and cannot be reached unless the pilot releases all controls and turns completely around. The heater ducting in the aircraft provides too much heat for the pilot, and too little for the passenger.

A glaring human factor and safety fault in the helicopter is the placement of the only fire extinguisher in the passenger's compartment, out of reach of the pilot.

During the FY 1970 test of the M35A2C 2½-ton truck, drivers complained about insufficient leg room and interference between brake and clutch pedals, especially when drivers were wearing bulky vapor barrier boots. The test group measured the clearance in the cab and found it to be below the standards set by the Human Engineering Laboratories—an obvious failure to consider the principles of human factor engineering during the design phase.

Colonel Edwin M. Rhoads, USA, is Commanding Officer of the U.S. Army Arctic Test Center, Fort Greely, Alaska. Prior to assuming this command, he was Chief, Ground Mobility Office, Development Directorate, Army Materiel Command; and before that served with the Military Assistance Advisory Group, Germany, first as Armor Advisor and later as Chief, Research and Development Section. Colonel Rhoads is a 1943 graduate of the U.S. Military Academy, West Point, N.Y.

FY 1971 Test Program

Forty-eight test items will be evaluated at the center during FY 1971, in addition to a number of continuing long range surveillance tests.

The M561 1¼-ton truck intended for forward combat units will be returned to the center for a preproduction test, with emphasis on the new winterization kit. The vehicle employs the articulation principle for steering, and is a wheeled counterpart of the M571 cargo carrier tested in FY 1969.

The M551 Sheridan airborne/assault vehicle will also be returned for tests of the personnel heating system and flame heater. At the same time, the AN/VSS 3 infrared searchlight will be mounted on the Sheridan for testing.

Improved and self-propelled versions of the Hawk air defense missile will be fired at the center by a team from the Air Defense Board at Fort Bliss, Tex.

The center will conduct four communications tests, a continuation of the evaluation of the Army Area Communication System.

The center's test pilots will fly the Huey Cobra (AH-1G) now employed in Vietnam, armed with XM28 and XM18 weapon systems for delivering machine gun, grenade and rocket fire.

Infantry personnel will evaluate the TOW antitank missile and its accessories, in addition to several fuzes, a counter ambush barrage weapon system, grenade launchers and lightweight sleeping gear.

Emphasis on airmobile operations is reflected in five tests related to airdropping of men and equipment. These include a ballistic reserve parachute, airdrop platforms and rigging systems.

Design for Northern Operations

In these and all future tests, the center will continue to look at equipment design for evidence of the application of the lessons learned about northern operations. The materials selected for use must be able to withstand extreme cold without losing their properties and, beyond that, they must be rugged and durable. Adequate winterization kits to provide proper battery heat should be designed into vehicles, not added on in random configurations. All components must be properly tested in cold chambers before environmental testing in the Arctic.

It is clear after 20 years of heater failures of the same nature that a new concept in heaters is called for. The current design has been declared unsuitable and unreliable during every test. An alternative design, utilizing new principles, should be developed.

Soldiers will avoid essential maintenance functions if they are difficult to perform in extreme cold. For this reason, equipment must be designed for ease of maintenance by a soldier wearing the bulky arctic mitten set and other arctic protective gear. Human factor engineering for the Arctic is as important for efficient functioning of equipment as any other design principle.

With the increasing intensity of economic development in the northlands, the military significance of the Area of Northern Operations will increase rather than decrease. The concept of future warfare recently enunciated by the Army Chief of Staff envisions a major increase in surveillance, target acquisition and automated fire control, highly mobile combat forces, and a commensurate increase in the mobility of forward logistic support. Already the capability for airmobile operations, so successfully employed in Southeast Asia, is receiving increased emphasis in the U.S. Army, Alaska.

With proper attention to the northern environment during design and development of the sophisticated weapon and combat support systems of the future, and with thorough testing at the Army's environmental test center in the heart of the North, not only will the Hawk be successfully challenged—it can be an ally of our combat forces against a human enemy anywhere in its domain.

FROM THE SPEAKERS ROSTRUM

Economic Impact of Defense Budget

Excerpt from address by Robert C. Moot, Asst. Secretary of Defense (Comptroller) before the American Ordnance Assn., Washington, D. C., April 30, 1970.

No one needs to be reminded that this is a time of change. Changes are occurring in the world political scene, in the environment, in technology, in national priorities, and in practically every aspect of life. This morning I would like to discuss a change with you that is of central importance to the Defense Department.

The FY 1971 budget represents a dramatic shift in national priorities and the revised Planning-Programming-Budgeting System (PPBS) was a key vehicle used to accomplish this change [See article "PPBS in Defense for the Seventies" *Defense Industry Bulletin*, May 1970, page 1.] A full appreciation of why the change was made can perhaps be best gained by reviewing the relationship between the total Federal budget and the DOD budget during previous war years.

During World War II and the Korean War, rising expenditures for military purposes were partially offset by relative decreases in Federal programs. Military expenditures rose from 16.3 percent of the Federal budget in 1940 to 83.9 percent in 1945. This pattern repeated itself from 1950 to 1953 during the Korean war, with a rise from 27.7 percent to 62.1 percent. During these war years, although the total Federal budget did increase significantly, domestic program funding was reduced or held static.

This pattern was broken, however, with the Vietnam War. Instead of absorbing a greatly increased percentage of the Federal budget, military expenditures actually declined slightly as a percentage of the budget, from 41.8 percent in FY 1964 to 41.5 percent in FY 1969. Domestic program funding actually increased at a greater rate than did the defense program.

Everyone recognizes that there has been a tremendous growth in the Federal budget in the last 10 years. The FY 1971 budget is more than double the FY 1961 budget. In absolute terms, the increase is more than $100 billion—$103 billion to be exact. What few people realize is that most of the increase is due to domestic programs. During this period, defense spending did increase by 61 percent. During this same period, however, domestic programs increased by 143 percent. This represents an increase for nondefense purposes of almost $80 billion out of the total increase of $103 billion. The impact of this pattern of increases on the economy was recognized by President Nixon in his FY 1971 budget message. I quote:

> "The current inflation was generated by the mounting budget deficits and rapid monetary expansion that began in 1965 with the escalation of the Vietnam War and the massive increases in Federal spending for domestic programs."

As you know, President Nixon has made the control of inflation one of the highest goals of his Administration. In bringing inflation under control, we should remember that we are not dealing with a temporary upswing in prices, but that the country has suffered under a sustained inflation for the past few years. Strong measures are necessary to turn this inflationary tide, and they cannot be expected to bring about results overnight.

Probably the most important single tool that the President can use to combat inflation is the Federal budget. There seemed to be little chance to produce a surplus by increasing taxes, since the country was anxious for repeal of the surtax and Congress was in the mood for tax reform. A reduction in the upward trend in Federal outlays was necessary to provide the fiscal restraint which the situation required.

Robert C. Moot is Assistant Secretary of Defense (Comptroller). Previously, he was Chief, Small Business Administration. He has also served as Deputy Administrator of the Small Business Administration and Deputy Assistant Secretary of Defense for Logistics Services.

When the President moves to reduce Federal outlays, he must address programs of the Defense Department. Only slightly more than half of the total Federal budget is controllable. The remainder is based on permanent legislation and includes relatively uncontrollable transfer and income maintenance payments such as social security, medicare, medicaid, interest and farm support. The outlays for these programs are based upon fixed formulas that are established by law and can only be changed through a

necessarily lengthy legislative process. The DOD budget accounts for more than two-thirds of the controllable portion of the budget which buys goods and services for the Federal Government. If a reduction must be made, two out of every three dollars will come from DOD. At the same time, the controllable portion of the budget that is for non-defense purposes includes many important domestic programs to meet the critical internal needs of the country. There is strong pressure to maintain these programs at the budgeted level. Thus, DOD had to fight a war on two fronts—Vietnam and inflation.

FY 1971 Budget

The FY 1969 defense budget of the last Administration cost $78.7 billion. Through reviews of the already submitted FY 1970 defense budget, outlays were reduced by the incoming Administration to $77 billion. The FY 1971 figures are perhaps more dramatic, since they reflect the full year impact of the reductions that were made during FY 1970.

In FY 1971, DOD outlays as a percentage of Gross National Product will be 7 percent. This is down from 8.7 percent in FY 1969, and is the lowest it has been since 1951. This percentage is very meaningful, for it shows how much of our total national output the President is proposing to use for military purposes, in lieu of personal consumption and investment as well as other government programs.

The percentage of DOD outlays to the total Federal budget shows the relative emphasis placed on military spending versus other government programs. For FY 1971, this percentage is 34.6 percent, which is the lowest it has been since 1950. In FY 1969, this percentage was 41.5 percent of the Federal budget.

There are a number of ways of measuring the extent of the reductions that have been made. A straightforward approach is to note that outlays were $78.7 billion in FY 1969 and are estimated at $71.8 billion for FY 1971, for a total decrease of $6.9 billion. However, the forces purchased for $78.7 billion in FY 1969 cannot be purchased in FY 1971 for the same amount, due to pay and price increases. Growth in the number of people receiving military retired pay has also contributed to increased costs and is a factor over which the DOD has no control. These necessary increases amount to $5.9 billion from FY 1969 to FY 1971. When this is added to the actual $6.9 billion reduction, the total reduction in the real defense program from FY 1969 to FY 1971 is $12.8 billion. I should point out that none of these figures include the FY 1971 pay raise [nor the recent 6 percent pay increase following the postal work slowdown].

The cost of inflation can perhaps be best appreciated by comparing the changes in payroll costs and personnel strengths over the past two years. In FY 1969, total DOD pay and related costs were $35.4 billion and military and civilian strength totaled 4.7 million. In FY 1971, pay and related costs will rise to $37.6 billion including the FY 1971 pay raise, while the total end-strength figures will drop to 4.1 million. Stated another way, in two years inflation has cost the department almost 682,000 people and $2.2 billion. Although of lesser magnitude, inflation has also had a similar impact on all other costs.

In addition to reducing the number of people on the direct DOD payroll, we have also estimated that reductions in procurement will cause the dislocation of 640,000 defense contractor and subcontractor personnel, for a total two-year reduction of 1.3 million people.

I believe that this 1.3 million will generally represent a temporary dislocation in the labor force, as these people move from defense-related employment to various tight labor markets. I would like to review very briefly where we currently stand in making these reductions.

Defense Employment Trends

Through the end of March, we had already made more than one-half of the reduction in DOD personnel, reducing 371,000 of the planned 682,000. In the same time period, employment in defense products industries has dropped by 129,000 for a total defense-related reduction of an even one-half million people in eight months.

One method that we are using to gain a better understanding of contractor employment trends is the DOD Economic Information System. Through this system, we receive semi-annual reports from about 450 plants engaged in defense work. Undoubtedly some of you here today submit this report. As of December 1969, employment in these plants was 1,015,000 and accounted for about one-half of the defense contractor employment. Based upon these reports, employment in these plants is projected to be reduced by some 325,000 by June 1971. This correlates closely with our estimate of 640,000 for total defense contractor employment reductions.

The Administration wants to use this knowledge well and do all that it can to avoid adverse economic impacts. The problem is receiving top level attention. An Inter-Agency Economic Adjustment Committee, chaired by Secretary of Defense Laird, has been established at the direction of the President to minimize adverse economic impacts. Every Cabinet department with major domestic programs is represented on this committee. The objective is to design programs that will minimize economic dislocation as resources move from defense to domestic uses.

Indicators of Defense Economic Activity

Our advance indicators of defense industry also tell us that resources will continue to move from defense business to other purposes. These advance indicators move before changes in production activity, so the full impact has not been felt. Let me cite the changes in a few indicators to give you an appreciation of the future. The base is the pre-Nixon year of 1968, compared with the latest monthly data collected by the Department of Commerce[1]:

- Gross DOD Obligations for Procurement—down 30.4 percent.
- Military Primary Contract Awards—down 27.7 percent.
- Unpaid Obligations Outstanding —down 19.9 percent.
- Manufacturers' New Orders for Defense Products—down 34.6 percent.
- Accession Rate—down 23.1 percent.
- Layoff Rate—up 316.7 percent.

[1] *Editor's note: Figures have been updated to reflect most recent data available.*

These figures reflect the use of FY 1970 funds. The funds earmarked for procurement in the FY 1971 budget are even lower, so the reduction can be expected to continue. The DOD FY 1971 procurement budget has been reduced by about one-third from the 1968 level. The impact of price increases can be eliminated by stating the FY 1971 procurement budget in constant dollars. The figure is $17.7 billion, which represents a decrease of 37.5 percent.

Historical Postwar Trends

This emerging pattern of increasing unemployment and decreasing production during the phasedown of a war should not be a surprise. I recently reviewed the trends in unemployment and the real Gross National Product after World War II and Korea.

In World War II from 1944 to 1946, military purchases were cut back by 83 percent and unemployment moved from 1.2 percent to 3.9 percent. There was a *decrease* of 12 percent in the real Gross National Product.

In the Korean War period from 1952 to 1954, military puchases were cut back by 15 percent and unemployment moved from 2.9 percent to 5.5 percent. There was a *decrease* of 1.4 percent in the real Gross National Product.

In the Vietnam War period from 1969 to 1971, military purchases are being cut back by $6.9 billion in current and $12.8 billion or 16 percent in constant dollars. The Council of Economic Advisers has forecast close to zero growth in real Gross National Product through mid-1970, with some real growth in the latter half of the year. In both of the historical periods, the economy adjusted fairly quickly to the change in national priorities and moved strongly upward.

To summarize, I know that the picture I paint is not rosy from a defense industry viewpoint. It is true that after reassessing national priorities, the President has decided to reallocate some resources from defense to domestic programs. It is true that this will involve large cuts in defense personnel, sharp reductions in defense procurement and, possibly, some temporary added unemployment.

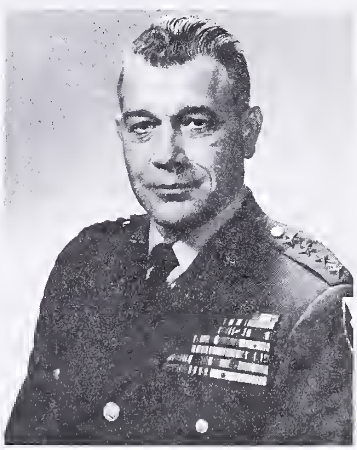
It is also true that the President has taken this action only after carefully assessing our military posture and our international commitments. We must also remember that even after the reductions I have outlined, the defense budget will continue to consume a significant percentage of our total national output.

As it always has in the past, I believe that DOD will once again turn to industry for solutions to the problems we face. Solutions are needed on how to provide adequate defense on a reduced budget. Ways must be found to reduce the cost of new weapons systems.

I am confident that industry will answer this challenge as successfully as it has responded to the challenges of the past.

A Strategy of Indirect Approach

Address by Gen. F. J. Chesarek, USA, Commanding General, Army Materiel Command, at Annual Meeting of the Chicago Chapter of the American Ordnance Assn., Chicago, Ill., April 23, 1970.



General Ferdinand J. Chesarek, USA, is Commander, U.S. Army Materiel Command. Previously, he was Assistant Vice Chief of Staff of the Army. A graduate of the U.S. Military Academy, West Point, N.Y., he also holds a Master of Business Administration degree from Stanford University.

New weapons and other major items of materiel are derived from the Army's Advanced Concepts Organizations—a triad consisting of intelligence people providing threat analysis, the Army Materiel Command's Advanced Materiel Concepts Agency, and the Combat Development Command's Institute of Land Combat. These organizations synthesize various force concepts with input from industry, the scientific community, and our in-house laboratories in order to propose designs of new materiel and doctrine capable of defeating the postulated threat.

This product is then critically reviewed and designs are selected for further analysis pertaining to the level of technical risk, probable cost, and effectivity. This screening process results in decisions "to go or no go." Then starts the long process of concept formulation, contract definition, engineering development, prototype construction and testing, tooling, more testing to include use of troops, and finally—hopefully—full scale production.

The whole process from birth of a materiel concept to hardware in the hands of troops may take anywhere from 15 to 20 years, if done in an orderly fashion with control of cost, configuration, schedule, and performance.

Obviously, in emergency conditions we would telescope this time frame but would expect to pay a heavy price in cost growth and degradation of performance.

The point I wish to make is that cutbacks in new starts in the 1970s will be felt most in the late 1980s and 1990s. Thus, if we cut back too far in funding for high quality and modern fighting gear, we could well be outclassed in future years.

In a recent speech to the National Security Industrial Association, Dr. John Foster, Director of Defense Research and Engineering, defined the sweeping challenge from abroad to America's technological leadership. Let me quote a few excerpts from his text:

"For many years now, the Soviet Union, clearly recognizing a prime source of national strength in the modern world, has emphasized research and development. Soviet expenditures for defense, space, and atomic energy technology have grown until they now exceed ours. Soviet efforts continue to expand rapidly. Our effort has leveled off and begun to decline.

"In civilian technology—particularly in the manufacture of technologically intensive products—Japan, West Germany, and others have achieved and sustained a growth rate several times ours for more than a decade. In selected areas, we no longer lead. We follow. No reversal of this trend is in sight."

Dr. Foster then proceeded to develop his point:

"In assessing the quality of Soviet defense-related research and development, I can give you two judgments. First, the United States retains a clear but narrowing overall technical lead. But second, the Soviet Union already has the resources and the advanced technology required for a vigorous challenge to the United States in many areas.

"The trend is grim—grim because we Americans have enjoyed a well founded confidence in our ability to meet any challenge in defense, in atomic energy, and in space. In the past, our confidence has sprung from our scientific and technological leadership. The unavoidable question is: Which country will be the more confident in the 1970s and 1980s?

". . . In military-related research and development, we can be sure about the consequences. With a larger effort, the Soviet Union will explore more areas of science and technology than will the United States. They will study many areas more thoroughly than will the United States. They will learn more. Having learned more, they will find more paths leading to higher performance military hardware of all kinds. Mr. Kosygin's successor will have more choices in his weapons and strategy than will Mr. Nixon's. Then, if the Russians so desired, they could choose to develop and deploy more kinds of advanced weapon systems. Some Soviet choices would be surprises. There would be more Soviet 'firsts' than American 'firsts.' In short, our ability to deter war would be weakened. The risks of war would rise."

Now, neither Dr. Foster nor I intend to sound the call of doomsday. Rather, we seek to inform our fellow citizens of the challenge and set it in proper perspective.

Frank Lloyd Wright once said:

"The human race built most nobly when limitations were greatest, and therefore when most was required of imagination in order to build at all."

There are a number of things we can do, with the help and understanding of our friends, to maintain a high quality, modern Army within reasonable budget constraints. The direction could be labeled "a strategy of indirect approach". Let me explain.

During the period 1960 to 1965, the Army's budget, averaged out over these five years, breaks out as follows: pay of our people—40 percent; operating costs—30 percent; investment in facilities and equipment—19 percent; and research and development—11 percent.

As the resources allocated to us decline, and as inflation in both wages and materiel continues, we not only have less to apportion to these accounts, but we get less for each dollar allotted.

The big money—70 percent—is in pay and operating costs. We must, therefore, devise ways and means of using less people to do our tasks and better ways of doing them, not only to live within our budget but at the same time generate substantial funds for a viable research and investment program.

This is the strategy of indirect approach. To a nation of innovators, entrepreneurs, and managers, this is a tolerable challenge. I would like to outline a few of the opportunities which should make this strategy successful.

Computers and ADP Equipment

First, expand and exploit the use of the computer and other automatic data processing equipment where we currently enjoy a strong international lead and where the payoff is very promising.

Recently, Dr. Glenn T. Seaborg, Chairman of the Atomic Energy Commission, in a speech at the Nobel Symposium in Stockholm, addressed this subject, and I would like to quote a paragraph of his address:

"One particular way in which the computer will serve . . . is by allowing us to create projections of possible futures or models of complex systems. These processes might be considered as an aid to—or perhaps a synthetic form of—wisdom. They give us a greater ability to look into the future in terms of what might happen should we act or not act in certain ways. . . . We can project alternatives, evaluate them, and offer people a choice. . . . In the future, we will have to depend on the computer to correlate the studies of all the experts, rather than depend on limited individual knowledge or often unreliable speculation."

In the Army, we are now proceeding along this line across the whole spectrum of our activities. We use computers in complex modeling work and simulations of all kinds. As our skill improves in their use and exploitation, we are able to solve complex, time-consuming problems quicker, provide better alternative choices, and make better analyses—in other words, reduce the long lead times which translate into dollars and people.

In the logistical areas, we are completing this month the programming of third generation computers for our

National Inventory Control Points and our depots. In the near term, this will permit consolidations with substantial strength reductions, increase our responsiveness to the field forces, and give us the kind of visibility we need to manage our resources better.

In our maintenance shops and arsenals, we are pushing hard for conversion to computer aided manufacture. Numerically controlled machine tools can produce big savings in our operating account and permit quick amortization, as well as aid in meeting our customers' demands.

Computers are helping us greatly in control, simplification, and production of technical data and its maintenance. Computer aided design will certainly become a standard way of business over the next 10 years.

In short, computers provide opportunities for major tradeoffs against units and strength. Properly and imaginatively utilized, they let us do more, much better, much faster, and with much less.

People and Machines

Another major area of great potential to permit man-machine tradeoffs is in designing simple, highly reliable, easily maintainable materiel. Reams have been written on this worthy objective with little done about it, either in the commercial or military sector. We and industry are both at fault. Because of the long lead time involved in weapon system development, there are strong tendencies to push the outer reaches of the state of the art and to incorporate in each system multiple capabilities. This adds up to highly sophisticated, complex, and very expensive equipment.

We are now in the process of taking a different course which will field quality materiel and substantially reduce cost in people and dollars. All of our new starts specify, in quantifiable terms, the reliability demanded. We have set up procedures to control changes and freeze designs at an early stage in the cycle. We are well into modular replacement to eliminate the need for hundreds of thousands of repair parts. The new creed is to produce simple, reliable, quality products. This will act to reduce the size of operating crews, save hundreds of thousands of maintenance hours, and reduce logistics support.

Logistics

A third major area for innovation is in the exploitation of containers.

Years ago, the Army invented the CONEX container—a steel box measuring about 8-by-8-by-4 feet—in which we transported fragile items such as communications gear and pilferable materiel. In recent years, we have been using them quite generally for the movement of cargo. About five years ago, an international effort was applied toward a standard container, which could be transported by rail, sea, air, or truck, regardless of the various national standards which tend to inhibit this sort of thing. At the present time, 24 percent of our cargo, exclusive of ammunition and major end items, moves to Vietnam by containers on ships especially designed for their quick loading and off-loading. Fifty-two percent of similar cargo destined for Europe is shipped by containers.

This is just a beginning in reducing double and triple handling, port charges, and other heavy expenses of break-bulk operations. In FY 1969, the Army spent about $2 billion for the transportation of people and things, so the stakes are high indeed.

The time has come to exploit the container to its full potential. . . .

I visualize a depot in any future contingency to consist of a group of specially built containers, carefully stocked and documented in the United States and delivered to designated points. The need for depot construction, ports, or over-the-beach operations will be sharply reduced. Similarly, containers can be used as maintenance facilities where each can be designed in the United States as a segment of a maintenance shop. Thus, we can safely reduce the requirements for special materiel to build depot and maintenance facilities, and save the cost of keeping them in a condition for immediate use.

This form of podularized logistics is cheap to construct, relatively indestructible, secure from pilferage and other loss, and can be accomplished in a fraction of the time currently employed. They may take the form of being encased in large air inflatable shelters for weather protection, air conditioning, or heat. Savings could amount to hundreds of millions of dollars.

Lasers

Next, we need to press forward with the exploitation of lasers. This fantastic phenomenon is just beginning to find itself. It not only measures distances with extreme accuracy, it also is being applied as a metal cutter on machinery in numerically controlled tools, for difficult welding operations, on construction equipment as horizontal reference means, for three-dimensional photography, and in the field of medicine. It has innumerable communications and computer memory potentials. Each of these applications saves people, money, and time—the key ingredients.

Future Priorities

I hope these few examples give you a fair idea of our approach. If our efforts prove successful, and I believe they will, we should generate a reasonable sum of money for equipment modernization. I know you are most interested in how we intend to use these funds.

I would hope to apply a high priority to the development and production of a new generation of munitions to increase effectiveness by a factor of four or five. We have made some breakthroughs during the past five years which open a new world in this complex area. Firepower equates to strength. After all, that's what all the effort is aimed at doing—overpowering the enemy.

The Army's priorities continue to place emphasis on air mobility, especially the helicopter gunship. Devices to improve our battlefield surveillance, night observation, and real time intelligence also enjoy high priority. Our efforts at developing better tank and antitank systems are well along with some now entering production. They must be funded. Similarly, we cannot afford to lack effective air defense systems. Anyone who has experienced attack from the air knows its devastating power. As these systems are expensive, little is likely to be left for other desirable programs.

For years we have boasted that our soldiers are the finest equipped in the world. Will they be in the following decades?

B–1 Contractors Selected

The Air Force has selected airframe and propulsion contractors for engineering development of the B-1 advanced strategic bomber. The contractors are North American Rockwell Corp., El Segundo, Calif., for the airframe; and the General Electric Co., Evendale, Ohio, for the engines.

No production was authorized, nor has there been a decision on whether or when production might begin or how many aircraft might be required. Funds for engineering development were approved by Congress in the FY 1970 budget.

In his authorization to proceed with the B-1 program, Deputy Secretary of Defense David Packard stated that "It will be several years before a production decision will be made. Factors to be considered in authorizing a production decision will include progress and success of the engineering development program, the progress of the SALT talks, and the relationship of this program to these talks."

Secretary Packard instructed Secretary of the Air Force Robert C. Seamans to "take appropriate action to assure that the contractor minimizes expenditures until: there is final Congressional action on the FY 1971 budget for this program; [and] the development schedules have been re-evaluated as necessary to reflect these Congressionally approved funding levels." He also required that "Equal opportunity compliance of both contracts must be reconfirmed before the contract is signed."

If changes in the funding situation require significant changes in schedule or cost estimates, the program must be reviewed by the Defense Systems Acquisition Review Council.

North American Rockwell Corp. will initially proceed with engineering and design, including fabrication of five flight test aircraft, one static test airframe and one fatigue test airframe, to be used in development testing. Total cost of the airframe work announced is estimated at $1,350,814,739. This total includes a target fee of $115,753,281, and funds for spares and special equipment to support the test program. It does not include cost of avionics. Initially $25,000,000 were obligated for airframe engineering development.

The General Electric Co. will begin engineering design, development and fabrication of 40 preliminary flight-test-rated engines for the flight test program. Total estimated cost is $406,654,000, which includes a target fee of $30,122,500, and funds for spares, and special support and test equipment. Initially, $10,000,000 were obligated for engine development.

The contracts will use cost plus incentive fee features, plus an award fee feature for outstanding overall accomplishment.

A contractor for the avionics will be selected at a later date.

System program director for the B-1 is Brigadier General Guy M. Townsend of the Air Force Systems Command.

Based on comparative costs of developing other new aircraft, and without benefit of contractor proposals, the Air Force estimated the total cost of B-1 production (at least 200 aircraft) would be $11.8 to $12.6 billion in 1968 dollars:

- Research, design, development, test and evaluation, and five test aircraft—$1.7 to $1.9 billion.
- Investment in aircraft, including initial spares, technical data and support equipment—$6.8 to $7.2 billion.
- Operation for 10 years—$3.3 to $3.5 billion.

These estimates do not include inflation factors, as budgets are not developed on the basis of projected inflation.

Over the past four years, the Air Force has spent more than $140 million for preliminary system design studies, and avionics and propulsion advanced developments, to identify and reduce technical risks. Seven spe-

cific avionic advanced development tasks, costing $42 million, have been completed or are in various stages of flight test.

In the propulsion area, about $72 million has been spent for design, fabrication and test of propulsion components and for demonstrator engines which closely approximated the size and cycle envisioned for the B-1. Several hundred hours of running time have been accumulated on these demonstrator engines.

The Air Force wants the B-1 to modernize the manned bomber element of the nation's strategic force by replacing the B-52. By the time operationally significant numbers of B-1s could be in the inventory, in CY 1977 or 1978, the newest of the B-52s would be 15 years old. The B-52H incorporates about the maximum growth attainable with the basic design, and represents the technology of the 1950s. If all technical milestones in the development of the B-1 are met, the first flight could be in June 1974.

As presently planned, the B-1 will be a supersonic bomber in the Mach 2 to 3 range at high altitude. Powered by four turbofan engines, the B-1 will have a gross take-off weight of 350,000 to 400,000 pounds, about two-thirds of the weight of the B-52. It will also be smaller than the B-52. The aircraft will be manned by a crew of two pilots and two navigator-systems officers.

The B-1 is planned to have an internal bomb bay about twice the size of the B-52. It will carry short range attack missiles (SRAM), subsonic cruise armed decoys (SCAD), bomber defense missiles (BDM), and nuclear and conventional weapons. It will also be able to carry external payloads.

In comparison with the B-52, the B-1 will have a smaller radar cross-section, penetrate at higher speeds and lower altitudes, be able to operate from dispersed austere bases, carry a greater payload, and be capable of more rapid launch. It will have high lift devices and short take-off and landing capabilities.

The aircraft will feature ability to shift and adapt range, altitude, and speed and payload for a variety of missions and tactics. It will contain electronic jamming equipment; infrared countermeasures; radar location, homing and warning; and other devices to protect itself, penetrate enemy defenses, and deliver its payload.

The national strategic force consists of bombers, land-based missiles and sea-based missiles. Manned bombers give the Air Force operational flexibility. They can be launched to test operational readiness, or to provide a show of force or level of readiness. They can be recalled to base prior to actual commitment of force.

Bombers can be used in conventional role or limited nuclear exchange where extreme accuracy is required. They can be assigned multiple targets or alternate targets as dictated by a changing tactical situation. Bombers can be recovered, reconstituted, and used to strike additional targets.

Winning B–1 Proposal Had Highest Rating, Lowest Bid

The following statement was issued by the Air Force on June 8:

"It has been reported that the bid of the winner in the B-1 competition was the highest bid and presented the least desirable design.

"This is not the case.

"North American Rockwell Corp. was the lowest bidder, received the highest weighted score, and was the unanimous choice at each reviewing level.

"When the contractors submitted their proposals, some 600 selected specialists reviewed and evaluated them over a period of months. The proposal was divided into a large number of sub-areas and basic evaluation scores were rendered by separate evaluation groups after they analyzed each of the sub-areas.

"These raw data were consolidated and presented to the Source Selection Advisory Council. After hearing the presentation of the evaluation group, the Source Selection Advisory Council went into executive session. In this executive session, the Advisory Council applied weighting factors to the raw evaluation date. These weighting factors had been created before contractors' proposals were received.

"They were not changed and were never made available to the members of the evaluation team which conducted the detailed analysis.

"The results of the Source Selection Advisory Council were formalized in writing and presented to the Secretary of the Air Force, who had the authority to select the winning contractor. In addition, this analysis and findings were presented to the Commander, Strategic Air Command, Commander, Air Force System Command, Commander, Air Force Logistics Command, the Air Force Council, and the Chief of Staff.

"All these individuals, as well as the Air Force Secretary's principal civilian advisors, reached the same conclusion as Secretary Seamans with respect to the contractor's proposal to be selected.

"The North American Rockwell Corp. received the highest weighted score of the three proposals and their negotiated bid was the lowest—some $1.35 billion compared to $1.45 billion and $1.56 billion for the other competing contractors.

"The contract is for development and testing of the new aircraft only. No decision has been made on whether production will be authorized."

We Apologize!

In May the *Bulletin* published a list of the NATO member countries (see NATO Industrial Advisory Group, p. 15). We unintentionally used incorrect names for four countries. We apologize, and correct the error with the following list of member countries:

Belgium
Canada
Denmark
France
Federal Republic of Germany
Greece
Iceland
Italy
Luxembourg
The Netherlands
Norway
Portugal
Turkey
United Kingdom
United States of America

Status of Funds Quarterly Report

Outlays

Third Quarter, Fiscal Year 1970

(Thousands of Dollars)

Department of Defense	Outlays				Unpaid obligations	
	Jan 1970	Feb 1970	Mar 1970	Cum thru 31 Mar 1970	At start of year	As of 31 Mar 1970
Military Personnel						
Active forces	1,801,712	1,722,760	1,741,215	15,997,638	592,306	677,350
Reserve forces	77,242	54,137	75,804	761,186	152,294	151,936
Undistributed	17,396	−62,533	−26,588	−112,515	—	112,515
Total—Military Personnel	1,896,350	1,714,364	1,790,431	16,646,309	744,601	941,800
Retired Military Personnel						
Retired Pay, Defense	244,551	247,966	246,092	2,100,805	6,354	9,259
Operation and Maintenance	1,736,207	1,717,217	1,745,680	16,062,539	3,924,991	3,775,443
Procurement						
Aircraft	621,153	506,622	711,127	5,948,184	7,701,062	5,427,147
Missiles	224,950	219,585	244,955	2,094,993	2,516,998	2,649,172
Ships	168,288	176,487	216,921	1,594,934	3,085,253	2,962,920
Tracked combat vehicles	24,224	32,667	26,079	219,647	454,414	368,201
Ordnance, vehicles and related equipment	444,176	450,376	441,071	3,800,999	5,690,581	4,710,339
Electronics and communications	98,490	92,915	115,119	851,832	1,621,409	1,448,009
Other procurement	199,960	130,080	124,165	1,421,787	2,016,381	1,921,572
Undistributed	−82,784	22,926	155,238	527,065	128,925	−256,737
Total—Procurement	1,698,457	1,631,657	2,034,673	16,459,441	23,215,023	19,230,625
Research, Development, Test, and Evaluation						
Military sciences	93,738	66,270	93,013	635,966	712,919	609,055
Aircraft	71,822	102,097	117,022	904,378	681,935	874,974
Missiles	154,987	194,722	173,304	1,658,665	1,077,605	1,191,274
Astronautics	52,453	63,964	44,961	595,995	452,428	406,994
Ships	32,261	29,290	33,990	267,166	284,836	281,588
Ordnance, vehicles and related equipment	26,621	28,519	27,369	243,021	229,411	177,522
Other equipment	69,353	68,721	76,922	678,858	501,780	477,709
Program-wide management and support	60,835	30,793	38,027	347,586	282,019	215,214
Undistributed	−7,322	−3,812	11,446	40,750	38,151	−11,190
Total—Research, Development, Test, and Evaluation	554,747	580,564	616,057	5,422,387	4,261,084	4,223,137
Military Construction	99,899	59,148	89,637	914,010	1,806,093	1,565,153
Family Housing	51,678	45,529	52,858	464,535	256,946	164,480
Civil Defense	6,222	6,419	7,724	60,028	55,255	49,298
Other—Special Foreign Currency Program	137	44	137	598	363	507
Revolving and Management Funds	160,245	−37,561	−197,004	−219,389	6,615,240	5,613,032
Applicable Receipts	−30,862	−9,639	−8,359	−107,905	—	—
Subtotal—Federal Funds	6,417,630	5,955,709	6,377,926	57,803,358	40,885,950	35,572,731
Trust Funds	1,362	−1,059	−1,010	3,125	4,821	3,919
Interfund Transactions	—	−2,049	−1	−4,662	—	—
Total—Military Functions	6,418,993	5,952,600	6,376,916	57,801,821	40,890,771	35,576,650
Military Assistance						
Federal Funds	31,841	57,901	37,214	423,693	1,562,839	1,288,909
Trust Funds	23,727	17,974	4,658	41,105	227,015	195,806
Total—Military Assistance	55,569	75,874	41,872	464,798	1,789,854	1,484,715
TOTAL—DEPARTMENT OF DEFENSE	**6,474,560**	**6,028,475**	**6,418,789**	**58,266,620**	**42,680,624**	**37,061,364**

Department of the Army

Department of the Army	Jan 1970	Feb 1970	Mar 1970	Cum thru 31 Mar 1970	At start of year	As of 31 Mar 1970
Military Personnel						
Active forces	723,573	733,088	745,701	6,507,465	213,798	292,752
Reserve forces	38,426	39,686	46,551	495,522	115,658	112,837
Undistributed	17,836	−58,662	−28,707	−124,183	—	124,183
Total—Military Personnel	779,835	714,112	763,545	6,878,804	329,457	529,772
Operation and Maintenance	605,128	677,922	602,855	5,753,965	1,337,348	1,226,597
Procurement						
Aircraft	69,210	52,663	57,854	632,273	1,063,782	708,264
Missiles	61,610	54,765	46,686	490,168	848,404	954,986
Tracked combat vehicles	23,408	32,042	24,201	206,992	431,068	340,447
Ordnance, vehicles and related equipment	264,118	199,395	176,744	1,741,298	2,965,280	2,349,294
Electronics and communications	31,677	27,350	22,335	260,437	581,475	453,528
Other procurement	45,320	40,575	25,552	312,744	682,896	709,162
Undistributed	−63,519	−6,086	152,425	483,915	39,722	−300,873
Total—Procurement	431,824	400,705	505,796	4,127,827	6,612,627	5,214,809
Research, Development, Test, and Evaluation						
Military sciences	11,328	10,993	13,689	104,965	96,888	93,664
Aircraft	5,733	4,947	15,736	60,293	89,782	78,512
Missiles	47,738	88,628	62,223	606,950	419,831	519,068
Astronautics	148	995	1,248	5,682	3,813	3,006
Ordnance, vehicles and related equipment	15,864	15,422	14,917	127,757	115,667	88,811
Other equipment	30,540	30,247	29,794	260,607	196,095	166,048
Program-wide management and support	4,369	3,957	4,781	42,125	32,104	30,548
Undistributed	12,371	−15,240	10,430	32,531	13,651	−23,842
Total—Research, Development, Test, and Evaluation	128,089	139,950	152,818	1,240,910	967,831	955,815
Military Construction	37,473	30,424	31,307	344,986	776,104	783,896
Revolving and Management Funds	16,620	−16,542	−73,393	47,132	1,856,891	1,436,386
Applicable Receipts	−28,085	−4,458	−2,730	−59,250	—	—
Subtotal—Federal Funds	1,970,883	1,942,114	1,980,198	18,334,374	11,880,257	10,147,276
Trust Funds	913	−1,266	−1,081	1,339	89	−376
TOTAL—DEPARTMENT OF THE ARMY	**1,971,795**	**1,940,847**	**1,979,118**	**18,355,713**	**11,880,346**	**10,146,900**

Department of the Navy

	Outlays				Unpaid obligations	
	Jan 1970	Feb 1970	Mar 1970	Cum thru 31 Mar 1970	At start of year	As of 31 Mar 1970
Military Personnel						
Active forces	554,617	469,168	478,849	4,688,261	168,734	273,855
Reserve forces	26,277	638	15,300	129,596	23,320	26,428
Undistributed	−5,746	4,366	−7,817	7,074	—	−7,074
Total—Military Personnel	575,149	474,171	486,331	4,824,930	192,054	293,209
Operation and Maintenance	437,246	432,157	468,396	4,219,348	1,537,613	1,521,299
Procurement						
Aircraft	187,097	179,589	215,360	1,809,119	2,861,615	2,115,068
Missiles	65,482	45,754	65,815	497,674	703,716	677,773
Ships	168,288	176,487	216,921	1,594,934	3,085,253	2,962,920
Tracked combat vehicles	816	625	1,878	12,655	23,346	27,754
Ordnance, vehicles and related equipment	87,126	111,935	145,283	1,055,045	1,536,287	1,316,406
Electronics and communications	34,287	39,112	50,746	319,900	576,715	528,643
Other procurement	96,948	51,185	79,900	707,141	1,194,841	1,079,449
Undistributed	−12,261	25,842	2,512	32,970	71,369	35,003
Total—Procurement	627,783	630,527	778,416	6,029,438	10,053,142	8,743,016
Research, Development, Test, and Evaluation						
Military sciences	14,626	14,301	11,689	123,318	129,992	108,544
Aircraft	36,692	39,590	66,940	394,169	253,929	506,141
Missiles	34,673	35,063	37,559	381,489	291,240	278,320
Astronautics	2,180	584	1,907	13,629	15,598	17,461
Ships	32,261	29,290	33,990	267,166	284,836	281,588
Ordnance, vehicles and related equipment	10,757	13,097	12,452	115,264	113,744	88,711
Other equipment	16,112	15,079	18,606	136,020	77,139	144,268
Program-wide management and support	19,860	4,460	9,696	77,210	219,464	153,966
Undistributed	−11,925	8,980	1,294	2,894	14,446	8,603
Total—Research, Development, Test, and Evaluation	155,236	160,444	194,133	1,511,159	1,400,388	1,587,602
Military Construction	33,494	3,292	34,610	262,963	616,207	581,034
Revolving and Management Funds	80,692	−170	−30,382	12,968	2,199,935	1,972,138
Applicable receipts	−2,106	−3,480	−2,571	−29,863	—	—
Subtotal—Federal Funds	1,907,495	1,696,940	1,928,933	16,830,943	15,999,338	14,698,297
Trust Funds	807	555	355	4,688	277	376
Interfund Transactions	—	−2,049	−1	−4,662	—	—
TOTAL—DEPARTMENT OF THE NAVY	1,908,301	1,695,447	1,929,288	16,830,970	15,999,615	14,698,673

Department of the Air Force

Military Personnel						
Active forces	523,522	520,505	516,663	4,801,911	209,774	110,742
Reserve forces	12,539	13,813	13,953	136,068	13,316	12,671
Undistributed	5,306	−8,237	9,937	4,595	—	−4,595
Total—Military Personnel	541,367	526,080	540,554	4,942,574	223,090	118,819
Operation and Maintenance	594,372	522,880	569,835	5,235,362	953,240	902,787
Procurement						
Aircraft	364,846	274,370	437,913	3,506,792	3,775,665	2,603,815
Missiles	97,858	119,066	132,454	1,107,151	964,878	1,016,413
Ordnance, vehicles and related equipment	92,845	139,013	119,002	1,004,048	1,188,875	1,044,544
Electronics and communications	32,360	26,136	41,504	266,769	455,843	460,674
Other procurement	49,265	31,526	14,116	345,574	95,195	89,036
Undistributed	−6,691	3,145	346	10,171	17,834	9,142
Total—Procurement	630,483	593,255	745,335	6,240,505	6,498,290	5,223,625
Research, Development, Test, and Evaluation						
Military sciences	14,315	11,267	12,302	106,345	90,842	82,127
Aircraft	29,397	57,560	34,346	449,916	338,224	290,321
Missiles	72,576	71,031	73,522	670,226	366,534	393,886
Astronautics	50,126	62,385	41,806	576,684	433,017	386,527
Other equipment	22,701	23,395	28,522	282,231	228,546	167,393
Program-wide management and support	36,606	22,376	23,550	228,251	30,451	30,700
Undistributed	−7,768	2,448	−278	5,325	10,054	4,049
Total—Research, Development, Test, and Evaluation	217,953	250,462	213,772	2,318,980	1,497,668	1,355,001
Military Construction	27,968	24,671	22,868	297,331	393,810	186,210
Revolving and Management Funds	39,560	10,079	−87,725	−266,155	1,276,941	1,336,484
Applicable Receipts	−669	−1,699	−3,056	−18,774	—	—
Subtotal—Federal Funds	2,051,033	1,925,729	2,001,583	18,749,824	10,843,039	9,122,924
Trust Funds	−358	−348	−284	−2,902	4,323	3,918
TOTAL—DEPARTMENT OF THE AIR FORCE	2,050,674	1,925,382	2,001,300	18,746,923	10,847,362	9,126,842

Defense Agencies/Office of the Secrtary of Defense	Outlays				Unpaid obligations	
	Jan 1970	Feb 1970	Mar 1970	Cum thru 31 Mar 1970	At start of year	As of 31 Mar 1970
Operation and Maintenance	96,597	80,947	101,235	822,863	93,268	123,187
Procurement						
Ordnance, vehicles and related equipment	87	33	42	608	139	95
Electronics and communications	166	317	534	4,726	7,376	5,164
Other procurement	8,427	6,794	4,597	56,328	43,449	43,925
Undistributed	−313	25	−45	9	—	−9
Total—Procurement	8,367	7,169	5,127	61,671	50,964	49,176
Research, Development, Test, and Evaluation						
Military sciences	53,469	29,709	55,333	351,838	395,197	324,720
Military Construction	963	761	851	8,729	19,972	14,014
Revolving and Management Funds	23,373	−30,927	−5,504	−13,334	1,281,474	868,024
Applicable receipts	−1	−3	—	−17	—	—
Subtotal—Federal funds	182,769	87,657	157,040	1,231,249	1,840,875	1,379,119
Trust funds	—	—	—	—	—	—
TOTAL—DEFENSE AGENCIES/OSD	182,769	87,657	157,040	1,231,249	1,840,875	1,379,119

Defense-Wide

Military Retired Personnel	244,551	247,966	246,092	2,100,805	6,354	9,259
Operation and Maintenance	2,864	3,311	3,359	31,001	3,523	1,573
Family Housing	51,678	45,529	52,858	464,535	256,946	164,480
Other Special Foreign Currency Program	137	44	137	598	363	507
TOTAL—DEFENSE-WIDE	299,231	296,850	302,446	2,596,939	267,186	175,818

Office of Civil Defense

Civil Defense	6,222	6,419	7,724	60,028	55,255	49,298

Obligations

Department of Defense	Available for obligation	Obligations			Cum thru 31 Mar 1970	Unobligated balance 31 Mar 1970
		Jan. 1970	Feb. 1970	Mar. 1970		
Military Personnel						
Active forces	20,021,034	1,817,784	1,757,667	1,746,440	16,343,511	3,677,523
Reserve forces	1,020,605	71,612	73,328	81,079	768,987	251,618
Total—Military Personnel	21,041,639	1,889,394	1,830,996	1,827,519	17,112,498	3,929,141
Retired Military Personnel						
Retired Pay, Defense	2,735,000	244,361	248,671	246,556	2,103,431	631,569
Operation and Maintenance	23,226,114	2,076,294	1,548,737	1,754,186	17,514,210	5,711,904
Procurement						
Aircraft	10,080,053	585,039	321,344	538,580	4,018,360	6,061,692
Missiles	4,103,069	139,687	220,546	132,466	2,281,231	1,821,837
Ships	5,011,431	210,897	109,434	113,089	1,541,929	3,469,502
Tracked combat vehicles & other weapons	367,526	24,637	13,814	16,269	201,252	166,274
Ordnance, vehicles and related equipment	6,830,441	355,209	297,305	285,860	4,104,779	2,725,662
Electronics and communications	2,202,752	104,985	71,215	71,771	771,016	1,431,736
Other procurement	3,077,726	140,223	132,655	265,237	1,567,259	1,510,467
Undistributed	−381,831	387	−1,730	3,903	−1,742	−380,089
Total—Procurement	31,291,168	1,561,060	1,164,583	1,427,177	14,484,083	16,807,085
Research, Development, Test, and Evaluation						
Military sciences	1,054,049	52,248	75,878	63,416	638,116	415,932
Aircraft	1,662,547	322,061	64,179	98,851	1,106,246	556,301
Missiles	2,501,354	153,217	109,432	138,197	1,890,572	610,782
Astronautics	875,158	61,514	51,567	47,288	598,262	276,895
Ships	359,289	11,716	15,646	15,751	271,507	87,782
Ordnance, vehicles, and related equipment	322,100	19,167	16,289	14,032	197,237	124,863
Other equipment	1,180,470	84,943	28,697	52,373	675,569	504,901
Program-wide management and support	676,870	49,229	41,811	45,625	435,590	241,280
Emergency fund	56,495	—	—	—	—	56,495
Undistributed	24,774	−977	−207	−269	−3,304	28,078
Total—Research, Development, Test, and Evaluation	8,713,105	753,118	403,296	475,259	5,809,794	2,903,311
Military Construction	3,125,617	78,951	154,430	201,282	1,032,661	2,092,956
Family Housing	689,917	59,015	35,162	33,588	384,636	305,281
Civil Defense	73,929	9,333	9,489	5,485	54,625	19,304
Other—Special Foreign Currency	15,162	50	37	271	742	14,419
Revolving and Management Funds	22,224,728	1,578,407	1,323,167	1,662,869	15,651,551	6,573,177
Offsetting receipts	−134,669	−32,327	−8,407	−8,434	−107,875	−26,794
Subtotal—Federal funds	113,001,710	8,217,656	6,710,160	7,625,759	74,040,356	38,961,354
Trust funds	79,854	5,502	3,725	2,604	44,743	35,110
Interfund transactions	−7,200	—	−2,049	−1	−4,662	−2,538
Total—Military Functions	113,074,364	8,223,157	6,711,836	7,628,364	74,080,438	38,993,926
Military Assistance						
Federal funds	420,145	85,022	7,339	51,968	284,747	135,399
Trust funds	1,983,792	31,544	13,812	5,533	8,494	1,975,298
Total—Military Assistance	2,403,937	116,566	21,151	57,501	293,241	2,110,696
TOTAL—DEPARTMENT OF DEFENSE	115,478,301	8,339,723	6,732,988	7,685,864	74,373,679	41,104,622

Department of the Army	Available for obligation	Obligations			Cum thru 31 Mar. 1970	Unobligated balance 31 Mar. 1970
		Jan. 1970	Feb. 1970	Mar. 1970		
Military Personnel						
Active forces	8,240,200	759,516	708,971	710,867	6,681,041	1,559,159
Reserve forces	665,400	46,157	45,414	51,563	500,832	164,568
Total—Military Personnel	8,905,600	805,672	754,385	762,430	7,181,873	1,723,727
Operation and Maintenance	8,532,137	695,457	599,189	704,014	6,310,569	2,221,568
Procurement						
Aircraft	810,672	8,930	21,152	74,936	292,560	518,112
Missiles	977,889	16,730	17,947	21,898	624,750	353,139
Tracked combat vehicles	322,194	24,259	13,807	16,259	184,189	138,005
Ordnance, vehicles and related equipment	4,180,897	180,623	198,267	127,227	2,406,339	1,774,558
Electronics and communications	782,486	43,733	15,485	10,679	171,630	610,856
Other procurement	968,730	40,463	32,525	165,237	387,591	581,139
Undistributed	153,942	1,425	193	308	−87	154,029
Total—Procurement	8,196,810	316,163	299,376	416,544	4,066,972	4,129,838
Research, Development, Test, and Evaluation						
Military sciences	184,763	10,800	8,645	10,307	130,539	54,224
Aircraft	138,708	1,617	9,312	6,198	52,948	85,760
Missiles	931,316	30,338	24,683	80,423	721,497	209,819
Astronautics	15,418	530	384	303	4,877	10,541
Ordnance, vehicles, and related equipment	205,517	6,899	7,488	10,362	107,124	98,393
Other equipment	474,427	18,174	23,082	24,109	241,714	232,713
Program-wide management and support	64,272	4,777	2,529	3,528	42,937	21,335
Undistributed	10,895	−20	−189	−43	−752	11,647
Total—Research, Development, Test, and Evaluation	2,025,316	73,115	75,934	135,187	1,300,884	724,432
Military Construction	1,386,408	34,490	66,935	175,704	544,751	841,657
Revolving and Management Funds	5,382,321	397,674	363,791	379,211	3,714,516	1,667,805
Applicable receipts	−67,611	−28,085	−4,360	−2,808	−59,178	−8,433
Subtotal—Federal Funds	34,360,981	2,294,486	2,155,250	2,570,282	23,060,387	11,300,594
Trust Funds	28,650	2,284	—	67	12,683	15,966
TOTAL—DEPARTMENT OF THE ARMY	34,389,632	2,296,769	2,155,252	2,570,348	23,073,070	11,316,561

Department of the Navy

Military Personnel						
Active forces	5,915,534	530,820	526,573	508,844	4,824,522	1,091,012
Reserve forces	176,570	13,532	14,435	15,716	133,534	43,036
Total—Military Personnel	6,092,104	544,352	541,007	524,561	4,958,056	1,134,049
Operation and Maintenance	6,321,977	572,361	378,452	440,457	4,790,998	1,530,979
Procurement						
Aircraft	2,818,669	242,693	97,305	135,795	1,102,791	1,715,878
Missiles	1,044,567	54,604	26,302	19,389	493,614	550,953
Ships	5,011,431	210,897	109,434	113,089	1,541,929	3,469,502
Tracked combat vehicles	45,332	378	7	10	17,063	28,269
Ordnance, vehicles and related equipment	1,387,265	140,993	67,120	101,728	838,159	549,106
Electronics and communications	588,291	39,086	21,087	29,509	277,378	310,913
Other procurement	1,491,580	51,384	60,397	80,320	777,819	713,761
Undistributed	−547,506	−1,250	−2,720	3,627	−3,086	−544,420
Total—Procurement	11,839,632	738,785	378,934	483,467	5,045,666	6,793,966
Research, Development, Test, and Evaluation						
Military sciences	145,380	12,158	10,402	7,703	106,771	38,609
Aircraft	850,022	221,258	18,877	42,737	646,450	203,572
Missiles	521,938	49,742	25,495	17,523	387,331	134,607
Astronautics	22,113	1,257	1,199	1,655	15,625	6,488
Ships	359,289	11,716	15,646	15,751	271,507	87,782
Ordnance, vehicles and related equipment	116,583	12,268	8,801	3,670	90,113	26,470
Other equipment	263,619	16,758	6,212	10,280	204,613	59,006
Program-wide management and support	282,749	31,676	−48	20,642	155,446	127,303
Undistributed	−5,613	−722	−142	−158	−2,157	−3,456
Total—Research, Development, Test, and Evaluation	2,556,080	356,111	86,442	119,803	1,875,699	680,381
Military Construction	1,212,206	38,059	78,081	7,262	395,450	816,757
Revolving and Management Funds	8,371,959	585,170	417,358	688,340	5,577,976	2,793,982
Applicable Receipts	−37,696	−3,265	−2,345	−2,572	−29,886	−7,810
Subtotal—Federal Funds	36,356,261	2,831,573	1,877,929	2,261,318	22,613,959	13,742,304
Trust Funds	16,252	1,447	1,142	834	9,724	6,528
Interfund Transactions	−7,200	—	−2,049	−1	−4,662	−2,538
TOTAL—DEPARTMENT OF THE NAVY	36,365,313	2,833,022	1,877,021	2,262,150	22,619,020	13,746,294

Department of the Air Force	Available for obligation	Obligations Jan. 1970	Feb. 1970	Mar. 1970	Cum thru 31 Mar. 1970	Unobligated balance 31 Mar. 1970
Military Personnel						
Active forces	5,865,300	527,448	522,123	526,729	4,837,948	1,027,352
Reserve forces	178,635	11,923	13,479	13,800	134,621	44,014
Total—Military Personnel	6,043,935	539,370	535,603	540,530	4,972,570	1,071,315
Operation and Maintenance	7,214,851	705,409	480,561	508,830	5,496,286	1,718,565
Procurement						
Aircraft	6,450,712	333,416	202,887	327,849	2,623,009	3,827,702
Missiles	2,080,613	68,353	176,297	91,179	1,162,867	917,745
Ordnance, vehicles and related equipment	1,261,604	33,498	31,879	56,858	859,717	401,887
Electronics and communications	822,860	21,714	34,097	31,519	319,494	503,366
Other procurement	492,628	42,360	35,372	9,916	339,415	153,213
Undistributed	10,217	212	797	−32	1,431	8,786
Total—Procurement	11,118,633	499,549	481,328	517,290	5,305,933	5,812,700
Research, Development, Test, and Evaluation						
Military sciences	178,614	5,709	18,815	9,925	114,814	63,800
Aircraft	673,817	99,186	35,990	49,916	406,848	266,969
Missiles	1,048,100	73,137	59,254	40,251	781,744	266,356
Astronautics	837,627	59,727	49,984	45,331	577,761	259,866
Other equipment	442,424	50,011	−597	17,984	229,242	213,182
Program-wide management and support	329,849	12,776	39,330	21,455	237,207	92,642
Undistrihuted	19,492	−235	124	−68	−395	19,887
Total—Research, Development, Test, and Evaluation	3,529,923	300,311	202,903	184,789	2,347,219	1,182,703
Military Construction	463,445	5,897	8,914	18,260	89,690	373,755
Revolving and Management Funds	4,869,140	411,656	345,915	382,125	4,262,742	606,398
Offsetting Receipts	−29,323	−976	−1,699	−3,054	−18,772	−10,551
Subtotal—Federal Funds	33,210,604	2,461,216	2,053,525	2,148,770	22,455,668	10,754,935
Trust Funds	34,952	1,771	2,582	1,703	22,336	12,616
TOTAL—DEPARTMENT OF THE AIR FORCE	33,245,556	2,462,986	2,056,107	2,150,474	22,478,004	10,767,552

Defense Agencies/Office of the Secretary of Defense

Operation and Maintenance	1,112,483	99,967	87,281	97,375	887,039	225,444
Procurement						
Ordnance, vehicles and related equipment	675	95	39	47	564	111
Electronics and communications	9,115	452	546	64	2,514	6,601
Other procurement	124,788	6,016	4,361	9,764	62,434	62,354
Undistributed	1,516	—	—	—	—	1,516
Total—Procurement	136,094	6,563	4,946	9,875	65,512	70.581
Research, Development, Test, and Evaluation						
Military sciences	545,292	23,581	38,016	35,481	285,992	259,299
Undistributed	—	—	—	—	—	—
Total—Research, Development, Test, and Evaluation	545,292	23,581	38,016	35,481	285,992	259,299
Military Construction	63,557	503	500	57	2,770	60,787
Revolving and Management Funds	3,601,308	183,908	196,102	213,194	2,096,317	1,504,991
Offsetting Receipts	−39	−1	−3	—	−39	—
Subtotal—Federal Funds	5,458,694	314,523	326,841	355,983	3,337,592	2,121,102
Trust Funds	—	—	—	—	—	—
TOTAL—DEFENSE AGENCIES/OSD	5,458,694	314,523	326,841	355,983	3,337,592	2,121,102

Defense-Wide

Retired Military Personnel						
Retired Pay, Defense	2,735,000	244,361	248,671	246,556	2,103,431	631,569
Operation and Maintenance	44,666	3,100	3,254	3,509	29,317	15,349
Research, Development, Test, and Evaluation						
Emergency Fund, Defense	56,495	—	—	—	—	56,495
Family Housing	689,917	59,015	35,162	33,588	384,636	305,281
Other—Special Foreign Currency Program	15,162	50	37	271	742	14,419
TOTAL—DEFENSE-WIDE	3,541,240	306,525	287,126	283,923	2,518,126	1,023,113

Office of Civil Defense

Civil Defense	73,929	9,333	9,489	5,485	54,625	19,304

Military Assistance

Federal Funds	420,145	85,022	7,339	51,968	284,747	135,399
Trust Funds	1,983,792	31,544	13,812	5,533	8,494	1,975,298
TOTAL—MILITARY ASSISTANCE	2,403,937	116,566	21,151	57,501	293,241	2,110,696

NOTE: All outlay amounts are on a net Treasury basis (gross payments less reimbursement collections), whereas obligations and unpaid obligations are on a gross basis (inclusive of reimbursable activity performed by components of DOD for each other). Therefore, unpaid obligations as of the end of the reporting month cannot be computed from other figures in this report.

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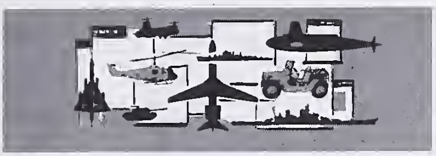

DEFENSE PROCUREMENT

Contracts of $1,000,000 and over awarded during the month of May 1970.

DEFENSE SUPPLY AGENCY

5—**Applied Technology Div., AVCO Corp.,** Lowell, Mass. $1,261,027. Body armor for aircrews, and small arms protective carriers. Golden, Colo., Garnerville, N.Y., and Lowell. Defense Personnel Support Center, Philadelphia, Pa. DSA 100–70–C–1740.

—**Tesoro Petroleum Corp.,** San Antonio, Tex. $1,257,798. Various quantities of gasoline and fuel oil. Defense Fuel Supply Center, Alexandria, Va. DSA 600–70–D–1452.

12—**Esso International, Inc.,** New York, N.Y. $1,680,250. 715,000 barrels of Navy distillate. Defense Fuel Supply Center, Alexandria, Va. DSA 600–70–D–0899.

22—**Steuart Petroleum Co.,** Washington, D.C. $6,535,003. 89,890,000 gallons of No. 6 fuel oil for federal agencies in the Washington, D.C., area. Defense Fuel Supply Center, Alexandria, Va. DSA–600–70–D–1975.

25—**Lester D. Lawson and Co.,** Long Beach, Calif. $1,822,652. 64,656 cases of ration supplement sundries pack. Modesto, Calif. Defense Personnel Support Center, Philadelphia, Pa. DSA 13H–70–C–S501.

—**United States Steel International, Inc.,** New York, N.Y. $1,087,755. 1,500,000 72-inch fense posts. Provo, Utah. Defense Construction Supply Center, Columbus, Ohio. DSA 700–70–D–0010.

26—**Kaiser Steel Corp.,** El Monte, Calif. $1,335,760. 1,200,000 32-inch fence posts and 800,000 96-inch fence posts. Fontana and Peco Rivera, Calif. Defense Construction Supply Center, Columbus, Ohio. DSA 700–69–D–0050.

28—**Texaco, Inc.,** Long Island City, N.Y. $1,622,167. Lubricants for military and civilian agencies. Defense Fuel Supply Center, Alexandria, Va. DSA 600–70–D–1917.

DEPARTMENT OF THE ARMY

1—**H. B. Zachery Co.,** San Antonio, Tex. $9,534,811. Work on the Lavon Dam and Reservoir, East Fork Trinity River, Collin County, Tex. Army Engineer District, Fort Worth, Tex. DA–CW63–70–C–0047.

—**American Dredging Co.,** Philadelphia, Pa. $1,557,888. Removal and disposal of all dredge material in Newark Bay, N.J. Army Engineer District, New York, N.Y. DA–CW51–70–C–0033.

—**Perini Corp.,** San Francisco, Calif. $3,495,791. Construction of the main dam and appurtenances, Mardis Creek Reservoir Project, Nevada County, Nev. Army Engineer District, Sacramento, Calif. DA–CW05–70–C–0089.

—**Bauer Dredging Co., Inc.,** Port Lavaca, Tex. $1,986,400. Construction and appurtenance work on the Lake Pontchartrain Hurricane Protection Project, Orleans and St. Bernard Parishes, La. Army Engineer District, New Orleans, La. DA–CW29–70–C–0203.

—**White Motor Corp.,** Lansing, Mich. $2,712,845. Engineering services for M44 and M602 series trucks. Army Tank Automotive Command, Warren, Mich. DA–AE07–70–C–3359.

—**Allis Chalmers Manufacturing Co.,** York, Pa. $3,886,100. Four 165,000 HP hydraulic turbines for the Libby Reservoir Project, Mont. Army Engineer District, Seattle, Wash. DA–CW67–70–C–0058.

—**Williams-McWilliams Co.,** New Orleans, La. $1,117,477. Rental of one 24-inch hydraulic dredge for work on the Greenville and Vicksburg Channels of the Mississippi River. Army Engineer District, Vicksburg, Miss. DA–CW38–70–C–0124.

—**Control Data Corp.,** Minneapolis, Minn. $3-891,939 (contract modification). Automatic data processing equipment. Safeguard System Command, Huntsville, Ala. DA–HC60–69–C–0017.

4—**Magline, Inc.,** Pinconning, Mich. $1,131,210 (contract modification). Electrical equipment shelters, S–208/G. Procurement Div., Army Electronics Command, Philadelphia, Pa. DA–AB05–69–C–0114.

—**The Melbourne Construction Co.,** Canton, Ohio. $3,826,000. Construction of an operating tower, discharge conduit, stilling basin, service bridge and appurtenant work, East Fork Reservoir-Little Miami River Project, Ohio. Army Engineer District, Louisville, Ky. DA–CW27–70–C–0092.

5—**McGinnes Brothers,** Houston, Tex. $1,623,176. Construction of a levee for the Port Arthur Hurricane-Flood Protection Project, Port Acres, Tex. Army Engineer District, Galveston, Tex. DA–CW64–70–C–0069.

—**Watson Construction Co.,** Minneapolis, Minn. $3,369,850. Construction of Phase I Safeguard site radar facilities, 8 miles east of Conrad, Mont. Army Engineer District, Huntsville, Ala. DA–CA87–70–C–0017.

—**Honeywell, Inc.,** Hopkins, Minn. $3,491,000 (contract modification). Classified development work. Picatinny Arsenal, Dover, N.J. DA–AA21–70–C–0096.

—**Goodyear Tire and Rubber Co.,** Akron, Ohio. $1,576,277. T130 track assemblies for M113 personnel carriers. St. Mary's, Ohio. Army Tank Automotive Command, Warren, Mich. DA–AE07–70–C–4152.

—**Penner Construction Co.,** Denver, Colo. $2,569,569. Design and construction of a field maintenance hanger, including all utilities and site work, Altus AFB, Okla. Army Engineer District, Fort Worth, Tex. DA–CA63–70–C–0052.

—**Olin Corp.,** East Alton, Ill. $6,662,000. Propellants. St. Marks, Fla., and East Alton. Frankford Arsenal, Philadelphia, Pa. DA–AA25–70–C–0613.

6—**Motorola, Inc.,** Scottsdale, Ariz. $1,000,000. Classified electronics equipment. Army Electronics Command, Fort Monmouth, N.J.

—**Pitts Manufacturing Corp.,** Memphis, Tenn. $1,093,655. Type G plugs for 155mm, 175mm and 8-inch shells. Army Ammunition Procurement and Supply Agency, Joliet, Ill. DA–AA09–70–C–0390.

—**AVCO Corp.,** Charleston, S.C. $1,106,000. Overhaul and/or repair of T–53–13/13A turbine engines for UH–1H or AH–1G helicopters. Army Aviation Systems Command, St. Louis, Mo. DA–AJ01–69–A–0308.

7—**Jensen Construction Co.,** Des Moines, Iowa. $2,878,821. Construction work at the Saylorville Reservoir Project, Des Moines River, Iowa. Polk County, Iowa, Army Engineer District, Rock Island, Ill. DA–CW25–70–C–0068.

—**Buckley Construction Co., Inc.,** Fenton, Mo. $1,923,733. Construction of recreation facilities, Shelbyville Reservoir Project, Kaskaskia River, Ill. Moultrie County, Ill. Army Engineer District, St. Louis, Mo. DA–CW43–70–C–0181.

—**Eugene Luhr and Co.,** Columbia, Ill. $3,952,767. Construction of substitute railroad facilities, bridge and tracks, Kaskaskie River Navigation Project, Randolph County, Ill. Army Engineer District, St. Louis, Mo. DA–CW43–70–C–0185.

8—**Tyee Construction Co.,** Bellevue, Wash. $2,526,090. Clearing 5,600 acres of the Dworshak Reservoir Project, north fork of the Clearwater River, Clearwater County, Idaho. Army Engineer District, Walla Walla, Wash. DA–CW68–70–C–0089.

—**Bell Helicopter Co.,** Hurst, Tex. $1,680,970. Advance development feasibility type helicopter with (HELMS) multi-function systems installed and flight tested in two HU-1C/M helicopters. Army Electronics Command, Fort Monmouth, N.J. DA–AB07–70–C–0149.

12—**Markham and Brown, Inc.,** Dallas, Tex. $1,173,090. Construction of a stone flood control dike on the Mississippi River and Tributaries channel improvement project, Chicot County, Ark. Army Engineer District, Vicksburg, Miss. DA–CW38–70–C–0129.

—**Standard Dredging Corp.,** New York, N.Y. $2,649,055. Dredging and construction work on the Savannah Harbor Project, Ga. Army Engineer District, Savannah, Ga. DA–CW21–70–C–0045.

—**Bell Helicopter Co.,** Fort Worth, Tex. $3,436,031 (contract modification). UH–1H utility helicopters. Hurst, Tex. Army Aviation Systems Command, St. Louis, Mo. DA–AJ01–70–C–0666.

13—**Guy F. Atkinson Co., Dravo Corp., Arundel Corp.,** and **L. E. Dixon Co.** (joint venture), San Francisco, Calif. $105,202,657. Construction of the main dam and appurtenant works, Lower Granite Lock and Dam, Snake River Project, Garfield and Whitman Counties, Wash. Army Engineer District, Walla Walla, Wash. DA–CW68–70–C–0088.

—**Oneglia and Gervasini Construction Co., Inc.,** Torrington, Conn. $5,843,882. Construction of levees and flood walls, pumping station and appurtenant works for the Local Flood Protection Project, Derby, Conn. New Haven, Conn. New England Army Engineer Division, Waltham, Mass. DA–CW33–70–C–0147.

—**General Motors Corp.,** Indianapolis, Ind. $3,488,949 (contract modification). Service research and development, and interim advanced production engineering effort on the MBT–70/XM803 Main Battle Tank. Milwaukee, Wis., Cleveland, Ohio, Muskegon, Mich., Indianapolis and other locations. Army Tank Automotive Command, Warren, Mich. DA–AE07–69–C–5272.

14—**General Electric Co.,** Burlington, Vt. $1,448,991 (contract modification). 20mm automatic guns, M61A1. Army Procurement Agency, New York, N.Y. DA–AG25–70–C–0204.

—**Standard Dredging Corp.,** New Orleans, La. $1,157,085. Rental of a hydraulic pipe line dredge and attendant plant for 154 days. Army Engineer District, Memphis, Tenn. DA–CW66–70–C–0107.

CONTRACT LEGEND

Contract information is listed in the following sequence: Date—Company — Value — Material or Work to be Performed—Location of Work Performed (if other than company plant) — Contracting Agency—Contract Number.

15—**Raytheon Co.**, Andover, Mass. $2,175,000 (contract modification). Engineering services for the improved Hawk missile system. Bedford and Andover, Mass., and White Sands Missile Range, N.M. Army Missile Command, Huntsville, Ala. DA–AH01–70–C–0195.

—**Wiley N. Jackson Co.**, Salem, Va. $4,498,-403. Construction and excavation work on the Central and Southern Florida Flood Control Project, Osceola County, Fla. Army Engineer District, Jacksonville, Fla. DA–CW17–70–C–0069.

—**Dixie Bridge Co., Inc.**, Lexington, Ky. $1,-432,434. Construction work at the R. D. Bailey Lake Project, Wyoming County, W. Va. Army Engineer District, Huntington, W. Va. DA–CW–70–C–0055.

—**Korshoj Construction Co., Inc.**, Blair, Neb. $1,437,410. Work on the Flood Protection —Blue River Federal Complex Project, Jackson County, Mo. Army Engineer District, Kansas City, Mo. DA–CW41–70–C–0091.

—**Texas Instrument, Inc.**, Dallas, Tex. $3,-540,540. AN/AAS–24 detecting sets, test equipment and ancillary items for the Mohawk OV–1D aircraft. Procurement Division, Army Electronics Command, Fort Monmouth, N.J. DA–AB07–69–C–0257.

18—**Gates and Fox Co., Inc.**, **Manson-Osberg, Co.**, and **Constructors-Panco** (joint venture), Loomis, Calif. $19,844,730. Construction of hydroelectric facilities, including installation of government furnished equipment, at the Snettisham Project, Juneau, Alaska. Army Engineer District, Anchorage, Alaska. DA–CW85–70–C–0020.

19—**H. C. Smith** and **Amelco Corp.** (joint venture), Compton, Calif. $4,773,402. Construction of Safeguard Perimeter Acquisition Radar Facilities, Phase I. Toole County, Mont. Army Engineer Division, Huntsville, Ala. DA–CA87–70–C–0020.

—**The Boeing Co.**, Ridley Park, Pa. $1,185,-000. Technical manuals, publications and work requirement for support of CH–47 helicopters. Morton, Pa. Army Aviation Systems Command, St. Louis, Mo. DA–AJ01–70–C–0524.

—**Weiss Construction Co.**, Brandon, Fla. $1,-722,450. Construction and appurtenant work, Central and Southern Florida Flood Control Project, Osceola County, Fla. Army Engineer District, Jacsonville, Fla. DA–CW17–70–C–0073.

20—Martin Marietta Corp., Orlando, Fla. $1,-124,411. TD–660/G multiplexers. Ocala, Fla. Procurement Division, Army Electronics Command, Fort Monmouth, N.J. DA–AB05–70–C–4116.

—**RCA**, Burlington, Mass. $1,017,076. Land Combat Support System equipment. Army Missile Command, Huntsville, Ala. DA–AH01–70–C–0845.

—**Dickerson, Inc.**, Monroe, N.C. $2,503,198. Relocation work of 20 miles of Norfolk-Southern Railway, New Hope Reservoir, New Hope, N.C. Wake, Chatham and Durham Counties, N.C. Army Engineer District, Wilmington, N.C. DA–CW54–70–C–0031.

—**Gust K. Newburg Construction Co.**, Chicago, Ill. $34,497,000. Construction of dam and appurtenance works, and removal of existing lock and dams 48 and 49, Uniontown Lock and Dam Project, Ohio River, Posey County, Ind., and Union County, Ky. Army Engineer District, Louisville, Ky. DA–CW27–70–C–0105.

21—**Peter Kiewit Sons, Inc.**, Omaha, Neb. $1,-989,000. Construction of an extension to the southeast runway, Offutt AFB, Neb. Army Engineer District, Omaha, Neb. DA–CA45–70–C–0077.

—**Winston Brothers Co.** and **Foley Brothers, Inc.** (joint venture), Minneapolis, Minn. $1,908,639. Excavation for the main dam, outlet conduit and access road, Ririe Reservoir, Willow Creek Project, Idaho. Army Engineer District, Walla Walla, Wash. DA–CW68–70–C–0094.

—**LTV Electrosystems, Inc.**, Huntington, Ind. $7,165,108. AN/VRC–12 compact lightweight vehicular radio set components. Procurement Div., Army Electronics Command, Philadelphia, Pa. DA–AB05–67–C–0171.

22—**Herlo Engineering Corp.**, Hawthorne, Calif. $1,538,606. M1 and M2 carbine barrel assemblies. Hawthorne and Long Beach, Calif. Army Weapons Command, Rock Island, Ill. DA–AF01–70–C–0827.

—**Gerbus Brothers Construction Co.**, Cincinnati, Ohio. $1,593,690. Construction of roads, culverts and bridges at six separate sites near the Paint Creek Dam, Highland and Ross Counties, Ohio. Army Engineer District, Huntington, W. Va. DA–CW69–70–C–0053.

—**Maro, Inc.**, Warren, Ark. $1,358,186. Road relocation work and construction of a bridge, DeQueen Reservoir, Rolling Fork River Project, Sevier County, Ark. Army Engineer District, Tulsa, Okla. DA–CW56–70–C–0131.

—**AVCO Corp.**, Charleston, S.C. $2,940,000. Overhaul and/or repair of T–53–L–13 engines for UH–1H and AH–1G aircraft. Army Aviation Systems Command, St. Louis, Mo. DA–AJ01–69–A–0308.

—**Western Electric Co.**, New York, N.Y. $5,411,250 (contract modification). Studies for the improved Spartan missile for the Safeguard Ballistic Missile Defense System. McDonnell-Douglas Corp., Santa Monica, Calif., and Bell Telephone Labs, Whippany, N.J. Safeguard System Command, Huntsville, Ala. DA–30–069–AMC–00333(Y).

—**Structures, Inc.**, Greenville, S.C. $2,999,-263. Structure removal work and construction of a superstructure on the Cross Florida Barge Canal Project, Marion County, Fla. Army Engineer District, Jacksonville, Fla. DA–CW17–70–C–0076.

25—**Bauer Dredging Co., Inc.**, Port Lavaca, Tex. $1,029,800. Maintenance dredging at the Mississippi River Gulf Outlet Project, Plaquemines Parish, La. Army Engineer District, New Orleans, La. DA–CW29–70–C–0228.

—**Union Carbide Corp.**, New York, N.Y. $2,-530,565. Type BA–4386/PRC–25 dry batteries, production testing, and engineering and first article samples. Charlotte, N.C. Procurement Div., Army Electronics Command, Philadelphia, Pa. DA–AB05–70–C–1472.

26—**Western Electric Co.**, New York, N.Y. $2,-175,114 (contract modification). Command and control equipment for Safeguard system Missile Site Radar tactical control site. Allentown, Pa. and Lexington, Mass. Safeguard System Command, Huntsville, Ala. DA–30–069–AMC–00333(Y).

—**Great Lakes Dredge & Dock Co.**, New York, N.Y. $15,470,000. Deepening and widening of channels and basins at the Fore and Town River, Weymouth, Mass., Project. Weymouth, Hull, Hingham and Quincy, Mass. Army Engineers New England Division, Waltham, Mass. DA–CW–33–70–C–0155.

—**Bohemia Lumber Co.**, Eugene, Ore. $5,973,-870. Construction on south jetty at the Yaquina Bay, Harbor, and River Project. Lincoln County, Ore. Army Engineers District, Portland, Ore. DA–CW–50–70–C–0125.

28—The Army Procurement and Supply Agency, Joliet, Ill., has issued the following contract modifications:

Day & Zimmerman, Inc., Philadelphia, Pa. $3,786,592. Loading, assembling and packing ammunition, and operating Army Ammunition Plant, Parsons, Kan. DA–AA–09–70–C–0245.

Day & Zimmerman, Inc., Philadelphia, Pa. $13,366,298. Loading, assembling and packing ammunition, and operating Lone Star Army Ammunition Plant, Texarkana, Tex. DA–11–173–AMC–114 (A).

Uniroyal, Inc., New York, N. Y. $6,662,-274. Operation of Joliet Army Ammunition Plant, and loading, assembling and packing of ammunition and related components. DA 11–173–AMC–62 (A).

Olin Corp., Stamford, Conn. $1,920,641. Loading, assembling and packing propellant charges, and operating Indiana Army Ammunition Plant, Charlestown, Ind. DA–AA09–69–C–0148.

Olin Corp., Stamford, Conn. $6,406,323. Loading, assembling and packing ammunition, and operation of Badger Army Ammunition Plant, Baraboo, Wis. DA–AA09–69–C–0014.

Thiokol Chemical Corp., Bristol, Pa. $3,-309,924. Loading, assembling and packing ammunition, and operating Long Horn Army Ammunition Plant, Marshall, Tex. DA 11–172–AMC–200 (A).

Harvey Aluminum Sales, Inc., Torrance, Calif. $3,665,836. Loading, assembling and packing ammunition, and operating Army Ammunition Plant, Milan, Tenn. DA 11–173–AMC–520 (A).

Atlas Chemical Industries, Inc., Wilmington, Del. $10,333,752. Plant maintenance and operation of the Volunteer Army Ammunition Plant, Chattanooga, Tenn. DA–11–173–AMC–00531.

Sperry Rand Corp., New York, N. Y. $24,367,565. Loading, assembling and packing ammunition, and operating Army Ammunition Plant, Shreveport, La. DA–11–173–AMC–00080 (A).

E. I. DuPont de Nemours & Co., Inc., Wilmington, Del. $2,009,601. Pre-operation activities in support of TNT production and operating Army Ammunition Plant, Newport, Ind. DA–AA09–68–C–0414.

Eastman Kodak Co., Kingsport, Tenn. $8,611,094. Production of explosives and support services, and operation of Holston Army Ammunition Plant, Kingsport. DA–11–173–AMC–0035 (A).

Hercules, Inc., Wilmington, Del. $16,-033,401. Rocket propellant production and operation of Sunflower Army Ammunition Plant, Lawrence, Kan. DA–11–173–AMC–00042 (A).

DVA Corp., Mount Laurel, N.J. $1,475,-761. Metal parts for M125A1 boosters. DA–AA09–70–C–0195.

Etowah Manufacturing Co., Inc., Gadsden, Ala. $1,469,850. Metal parts for M125A1 boosters. DA–AA09–70–C–0196.

Chamberlain Manufacturing Corp., New Bedford, Mass. $2,444,040. Metal parts for 155mm projectiles (M107). DA–AA09–70–C–0075.

—**General Motors Corp.**, Indianapolis, Ind. $12,712,577 (contract modification). Research and development and interim advance production engineering effort on MBT–70/XM803 Main Battle Tank. Milwaukee, Wis.; Cleveland, Ohio; Kalamazoo, Mich.; Muskegon, Mich.; Indianapolis and other locations. Army Tank Automotive Command, Warren, Mich. DA–AE07–69–C–5272.

—**Walter Toebe & Co., and Sugden, Inc.**, (joint venture), Wixon, Mich. $11,565,036. Construction of Section A at River Rouge Flood Control Project. Wayne County, Mich. Army Engineers District, Detroit, Mich. DA–CW35–70–C–0041.

—**Allied Products**, Denton, Tex. $1,167,407. Two-wheeled trailer chassis (M353). Curtis Field, Brady, Tex. Army Tank Automotive Command, Warren, Mich. DA–AE07–70–C–4622.

—**Baldwin Electronics, Inc.**, Little Rock, Ark. $1,000,080. Loading, assembling and packing motors for 2.75-inch rockets. Camden, Ark. Picatinny Arsenal, Dover, N. J. DA–AA21–70–C–0306.

—**Anderson Construction Co., Inc.**, Holton, Kan. $1,672,787. Construction of outlet works on Optima Dam, North Canadian River, Okla., Project. Texas County, Okla. Army Engineers District, Tulsa, Okla. DA–CW–56–70–C–0143.

—**Sanford Construction Co.**, Cleveland, Ohio. $1,591,480. Construction of repair shop, ambulance garage, and additions to existing buildings at Army Ammunition Plant, Ravenna, Ohio. Army Engineers District, Louisville, Ky. DA–CA27–70–C–0033.

—**Allis-Chalmers Manufacturing Co.**, Milwaukee, Wis. $1,502,123. Electric fork-lift trucks. Matteson, Ill. Army Mobility Equipment Command, St. Louis, Mo. DA–AK01–70–C–6842.

—**Lueder Construction Co.**, Omaha, Neb. $1,813,852. Design and construction of 100 family housing units at Fort Leavenworth, Kan. Army Engineers District, Kansas City, Mo. DA–CA41–70–C–0047.

—**Campanella Corp.**, Warwick, R. I. $4,196,-500. Construction of breakwater in vicinity of Provincetown, Mass. Army Engineers New England Div., Waltham, Mass. DA–CW33–70–C–0156.

DEPARTMENT OF THE NAVY

4—**Grumman Aerospace Corp.**, Bethpage, N.Y. $6,800,000 (contract modification). F-14A maintenance trainer. Bethpage and Calverton, N.Y. Naval Air Systems Command, Washington, D.C. N00019-69-C-0422.

—**Raytheon Co.**, Lexington, Mass. $5,874,010 (contract modification). Sparrow missile guidance and control sections for the Navy and Air Force. Lowell and Bedford, Mass., and Bristol and Oxnard, Tenn. Naval Air Systems Command, Washington, D.C. N00019-69-C-0358.

—**Howard Construction Co., Inc.**, Greensboro, N.C. $4,832,000. Construction of a sanitary and industrial sewer system, Charleston, S.C., Naval Base. Naval Facilities Engineering Command, Washington, D.C. N62467-67-C-0344.

—**General Dynamics Corp.**, Groton, Conn. $1,426,086 (contract modification). Engineering, planning and design services in support of conventional and nuclear submarine noise reduction program. Naval Ship Systems Command, Washington, D.C. N00024-69-C-0239 P005.

—**Welex Electronics Div., Haliburton Co.**, Silver Spring, Md. $1,151,320. Services in support of the AN/BQQ-1, -2 and -3, and AN/BQS-11, -12 and -13 sonor systems. Naval Regional Procurement Office, Brooklyn, N.Y. N00140-70-D-0520.

5—**Raytheon Co.**, Portsmouth, R.I. $3,907,354 (contract modification). Three AN/BQS-11/12 submarine sonar range detection units. Naval Ship Systems Command, Washington, D.C. NObsr 95304 Mod 19.

—**General Motors Corp.**, Goleta, Calif. $1,550,000. Mk 107 Mod 0 warheads and associated equipment for use with Mk 48 Mod 1 torpedoes. Naval Ordnance Systems Command, Washington, D.C. N00017-70-C-1302.

6—**Johns Hopkins University**, Silver Spring, Md. $4,961,400 (contract modification). Advanced research on the surface missile system. Naval Ordnance Systems Command, Washington, D.C. N00017-62-C-0604.

—**United Aircraft Corp**, East Hartford, Conn. $2,861,408 (contract modification). TF-30-P-412 engines. Naval Air Systems Command, Washington, D.C. N00019-70-C-0208.

—**Magnavox Co.**, Fort Wayne, Ind. $1,889,000. Set up test and repair facility at Magnavox for AQA7 DIFAR in P-3 aircraft. Navy Aviation Supply Office, Philadelphia, Pa. N00383-70-A-0901-0066.

—**Republic Electronic Industries Corp.**, Melville, N.Y. $1,810,331. AN/ARV-52(V) navigational sets. Naval Aviation Supply Office, Philadelphia, Pa. N00383-70-C-3436.

7—**Rohr Corp.**, Chula Vista, Calif. $9,564,434. 61 mechanized landing craft, LCM-8. Naval Ship Systems Command, Washington, D.C. N00024-70-C-0292.

—**Kaman Aircraft Corp.**, Bloomfield, Conn. $3,500,000 (contract modification). Long lead-time items for conversion of UH-2A/B helicopters to HH-2D configuration. Naval Air Systems Command, Washington, D.C. N00019-70-C-0051.

8—**Admiral Systems Corp.**, Chicago, Ill. $3,728,495. AN/ARC-51 aircraft radio sets. Naval Aviation Supply Office, Philadelphia, Pa. N00383-70-C-3434.

—**McDonnell Douglas Corp.**, Long Beach, Calif. $2,807,000 (contract modification). Long lead-time items for TA-4J and A-4M aircraft. Naval Air Systems Command, Washington, D.C. N00019-67-C-0170.

—**LTV Aerospace Corp.**, Dallas, Tex. $1,600,000 (contract modification). Development of interface between A-7 aircraft avionics and VAST system. Naval Air Systems Command, Washington, D.C. N00019-69-C 0536.

11—**Norris Industries**, Los Angeles, Calif. $13,706,405. Mk 81 Mod 1 bomb bodies, Vernon, Calif. Naval Ship Parts Control Center, Mechanicsburg, Pa. N00104-70-CA-139.

—**Dynell Electronics Corp.**, Melville, N.Y. $1,753,937. Development of Navy submarine acoustic-warfare intercept receiver system. Naval Ship Systems Command, Washington, D.C. N00024-70-C-1283.

—**Daniel and House Construction Co.**, Monterey, Calif. $1,581,855. Construction of a library facility, Naval Postgraduate School, Monterey. Naval Facilities Engineering Command, Washington, D.C. N62474-69-C-0156.

—**LTV Aerospace Corp.**, Dallas, Tex. $19,040,000 (contract modification). Long lead time items for Navy A-7E aircraft. $5,447,863 (contract modification). Long lead time for A-7D aircraft for the Air Force. Naval Air Systems Command, Washington, D.C. N00019-68-C-0075 and N00019-67-C-0143.

12—**IBM Corp.**, Owego, N.Y. $54,421,485. AN/BQS submarine sonar systems. Naval Shop Systems Command, Washington, D.C. N00024-70-C-1300.

—**Lasko Metal Products, Inc.**, West Chester, Pa. $1,374,600. Snakeye bomb fins, Mk 15 Mod 2. Naval Ship Parts Control Center, Mechanicsburg, Pa. N00104-70-C-A150.

—**United Aircraft Corp.**, Hartford, Conn. $39,021,603. Product support engineering services for TF-30 series engine for the Navy and Air Force. Naval Air Systems Command, Washington, D.C. N00019-70-C-0209.

—**Raytheon Co.**, Goleta, Calif. $2,780,172. AN/ALQ-76 transmitters and ancillary items. Naval Air Systems Command, Washington, D.C. N00019-70-C-0527.

—**Hughes Aircraft Co.**, Culver City, Calif. $2,600,000 (contract modification). Incremental funding for Phoenix missiles. Naval Air Systems Command, Washington, D.C. N00019-67-C-0240.

—**Texas Instruments, Inc.**, Dallas, Tex. $1,390,244. AN/ASQ-81 magnetic detecting sets. Naval Air Systems Command, Washington, D.C. N00019-70-C-0433.

13—**Lockheed Aircraft Corp.**, Burbank, Calif. $2,500,000 (contract modification). Long lead time items to support procurement of RP-3D aircraft. Naval Air Systems Command, Washington, D.C. N00019-69-C-0237.

—**Hughes Aircraft Co.**, Fullerton, Calif. $2,532,843. AN/SPS-52 radars and peripheral equipment. N00024-70-C-1346. $3,701,466 (contract modification). AN/SPS-33 shipboard radar equipment modernization. N00024-69-C-1244. Naval Ship Systems Command, Washington, D.C.

14—**Lockheed, Missile and Space Co.**, Sunnyvale, Calif. $1,395,000. Continued research and development work in deep submergence vehicle technology. Naval Ship Systems Command, Washington, D.C. N00024-70-C-0254.

—**PRD Electronics, Inc.**, Jericho, N.Y. $1,494,219 (contract modification). AN/USM-247 avionics test stations for A-7E aircraft. Naval Air Systems Command, Washington, D.C. N00019-69-C-0334.

—**Coronis Construction Co.**, Winchester, Mass. $1,875,000. Construction of 100 family housing units, Naval Air Station, Quonset Point, R.I. Naval Facilities Engineering Command, Washington, D.C. N62464-69-C-0219.

15—**Fedrick-Sundt** (joint venture), Novato, Calif. $1,641,251. Construction of an industrial waste system, Naval Shipyard, Mare Island, Calif. Naval Facilities Engineering Command, Washington, D.C. N62474-69-C-0160.

18—**Northrop Carolina Inc.**, Asheville, N.C. $3,223,461. Aircraft parachute flares, Mk 24 Mod 4. Swannanoa, N.C. Naval Ship Part Control Center, Mechanicsburg, Pa. N00104-70-C-A069.

—**Ingalls Shipbuilding Div., Litton Systems**, Pascagoula, Miss. $2,967,242. Advanced planning, design and material procurement for the overhaul of the USS Greenling, SSN-614. Naval Ship Systems Command, Washington, D.C. N00024-70-C-0280.

—**General Dynamics Corp.**, Groton, Conn. $1,824,047 (contract modification). Engineering and planning yard services for operational fleet ballistic missile submarines. Naval Ship Systems Command, Washington, D.C. N00024-69-C-0240 P007.

—**FMC Corp.**, Fridley, Minn. $1,290,000. Preparation of documentation for the 5-inch 54 caliber Mk 42 Mod 10 gunmount. Naval Ordnance Station, Louisville, Ky. N00197-70-C-0168.

19—**PRD Electronics, Inc.**, Syosset, N.Y. $2,814,332. Services and materials for the VAST (Versatile Avionics Shop Test) program. Naval Air Systems Command, Washington, D.C. N00019-68-C-0449.

—**Hughes Aircraft Co.**, Los Angeles, Calif. $2,417,002. Design data and long lead time items for a 15C9 missile control officer trainer for the F-14A aircraft. Naval Training Device Center, Orlando, Fla. N61339-70-C-0255.

—**Marquardt Co.**, Ogden, Utah. $2,672,023. Aerial tow target launchers. Naval Air Systems Command, Washington, D.C. N00019-70-C-0538.

—**Litton Systems, Inc.**, Van Nuys, Calif. $1,500,000. Studies, modification kits, and installation, and supporting data for the Tactical Air Operations Center, AN/TYQ-2. Headquarters, Marine Corps, Washington, D.C. M00027-70-C-0137.

20—**Lockheed Aircraft Corp.** Sunnyvale, Calif. $198,056,279. Poseidon missiles. Naval Strategic Systems Project Office, Washington, D.C. N00030-70-C-0092.

—**Hughes Aircraft Co.**, Culver City, Calif. $13,300,000 (contract modification). AN/AWG-9 airborne missile control systems. Tucson, Ariz., and Canoga Park, Culver City, Los Angeles and El Segundo, Calif. Naval Air Systems Command, Washington, D.C. N00019-70-C-0207.

—**Lockheed Aircraft Corp.**, Marietta, Ga. $3,446,967 (contract modification). Progressive aircraft rework on C-130s. Naval Air Systems Command, Washington, D.C. N00019-70-C-0153.

—**General Dynamics Corp.**, Groton, Conn. $1,769,191. Engineering and design services in support of the C-3 Poseidon weapon system development on the SSBN class conversion program. Naval Ship Systems Command, Washington, D.C. N00024-70-C-2085.

21—**Univac Div., Sperry Rand Corp.**, St. Paul, Minn. $5,510,000. Mk 152 Mods 1, 2 and 3 digital computers and associated ancillary equipment for modernization of Tartar and Talos fire control systems. Naval Ordnance Systems Command, Washington, D.C. N00017-69-C-2326.

—**Ingalls Shipbuilding Div., Litton Systems, Inc.**, Pascagoula, Miss. $4,950.000 (contract modification). Overhaul of the USS Darter (SS-576). Naval Ship Systems Command, Washington, D.C. N00024-69-C-0282.

—**Curtiss-Wright Corp.**, Wood Ridge, N.J. $2,828,032. Cylinder assemblies for R-1820-80/82/84/86 aircraft engines. Naval Aviation Supply Office, Philadelphia, Pa. F41608-69-A-0057-GBJC.

—**McDonnell Douglas Corp.**, St. Louis, Mo. $1,184,000 (contract modification). F-4E and RF-4C aircraft for the Air Force. Naval Air Systems Command, Washington, D.C. N00019-69-C-0521.

—**Texas Instruments, Inc.**, Dallas, Tex. $1,107,819. Design and fabrication of guidance and control components and subassemblies for the Extended Guided Projectile Program. Naval Weapons Laboratory, Dahlgren, Va. N00178-70-C-0182.

—**IBM Corp.**, Owego, N.Y. $1,129,866. Line items for A-6A aircraft navigational instrument subassemblies. Naval Aviation Supply Office, Philadelphia, Pa. N00383-70-A-4401-0016.

—**FMC Corp.**, Minneapolis, Minn. $1,018,122. Replacement parts for Mk 42 Mod 9 5-inch 54 caliber gun mounts. Naval Ships Parts Control Center, Mechanicsburg, Pa. N00104-70-A-0033.

22—**Univac Div., Sperry Rand Corp.**, St. Paul, Minn. $1,493,948. 642B computers, spare parts and engineering services. Salt Lake City, Utah, and St. Paul. Naval Ship Systems Command, Washington, D.C. N00024-70-C-1213.

—**Honeywell, Inc.**, Minneapolis, Minn. $1,493,892. Air munitions. Naval Air Systems Command, Washington, D.C. N00019-70-C-0176.

26—**General Electric Co.**, W. Lynn, Mass. $2,429,430. Retrofit kits for T58-GE8 helicopter engines. Naval Aviation Supply

Office, Philadelphia, Pa. F34601-70-A-0962-GB07.

—**Singer-General Precision, Inc.**, Little Falls, N.J. $1,452,000. Materials for test sets for aircraft radars. Naval Aviation Supply Office, Philadelphia, Pa. N00383-68-A-3201-0321.

—**Grumman Aerospace Corp.**, Bethpage, N.Y. $3,000,000 (contract modification). Conversion of A-6A aircraft to a KA-6D configuration. Stuart, Fla., and Bethpage. Naval Air Systems Command, Washington, D.C. N00019-70-C-0458.

—**Lockheed Missiles Space Co.**, Sunnyvale, Calif. $1,931,964. Fleet Ballistic Missile reentry studies and analyses. Navy Strategic Systems Project Office, Washington, D.C. N00030-70-C-0165.

—**C. W. Matthews Contracting Co., Inc.**, Marietta, Ga. $1,327,500. Construction of aircraft parking apron and hydrant fueling at Charleston AFB, S.C. Naval Facilities Engineering Command, Washington, D.C. N62467-69-C-0198.

—**Leon H. Perlin Co., Inc.**, Newport News, Va. $1,421,000. Construction of guided missile maintenance facility at Naval Weapons Station, Yorktown, Va. Naval Facilities Engineering Command, Washington, D.C. N62470-70-C-0880.

27—**PRD Electronics, Inc.**, Syosset, N.Y. $6,156,000 (contract modification). Versatile Avionics Shop Test (VAST) stations for E-2C aircraft. Naval Air Systems Command, Washington, D.C. N00019-69-C-0334.

—**Honeywell, Inc.**, Minneapolis, Minn. $4,500,000. Air munitions for Navy. St. Louis Park, Minn. Naval Air Systems Command, Washington, D.C. N00019-70-C-0530.

—**Goodyear Aerospace Corp.**, Akron, Ohio. $1,223,740. SUBROC guided missile production (Mark 28, Mod 1). $1,743,515 (contract modification). SUBROC missile production. Naval Ordnance Systems Command, Washington, D.C.

—**Baird-Atomic, Inc.**, Bedford, Mass. $2,006,646. Fluid analyses spectrometers. Naval Purchasing Office, Washington, D.C. N00600-70-C-1090.

—**Ruscom Construction Co.**, Charleston, S.C. Construction of nuclear refueling facility at Naval Shipyard, Charleston, S.C. Naval Facilities Engineering Command, Washington, D.C. N62467-68-C-0235.

28—**Lockheed Aircraft Corp.**, Burbank, Calif. $79,389,235. Production of P-3C aircraft. Naval Air Systems Command, Washington, D.C. N00019-70-C-0158.

DEPARTMENT OF THE AIR FORCE

4—**General Electric Co.**, Cincinnati, Ohio. $3,106,880. Stage one nozzles for J-79 aircraft engines. Oklahoma City Materiel Area, AFLC, Tinker AFB, Okla. F34601-69-A-1029.

5—**Aerojet General Corp.**, Sacramento, Calif. $15,994,739. Stage II motors for Minuteman III missiles. Space and Missile Systems Organization, AFSC, Los Angeles, Calif. F04701-69-C-0138.

—**Aerojet Liquid Rocket Co., Aerojet General Corp.**, Sacramento, Calif. $4,500,000. First and second stage engines for Titan III B/C/D. Space and Missile Systems Organization, Los Angeles, Calif. F04695-67-C-0097.

—**Explosive Corp. of America**, Issaquah, Wash. $1,557,000. Munitions and component parts. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33657-70-C-0636.

—**Fairchild Camera and Instrument Corp.**, Syosset, N.Y. $1,407,000. KA-82B camera equipment and related spare parts for RF-4B aircraft. Ogden Air Materiel Area, AFLC, Hill AFB, Utah. F42600-70-C-3443.

6—**Superior Steel Ball Co.**, New Britain, Conn. $2,630,040. Component parts for munitions. Ogden Air Materiel Area, AFLC, Hill AFB, Utah. F42600-70-C-1271.

—**Goodyear Aerospace Corp.**, Litchfield Park, Ariz. $1,611,263. All-weather topographical radar mapping systems. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33657-70-C-0769.

—**General Dynamics Corp.**, Fort Worth, Tex. $20,768,000. F-111F aircraft. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. AF33(657)13403.

—**Forsberg and Gregory, Inc.**, Redlands, Calif. $5,361,757. Construction of family housing units. Davis-Monthan AFB, Ariz. 12th Strategic Aerospace Division, Davis-Monthan AFB, Ariz. F02601-70-C-0260.

7—**Aerojet-General Corp.**, Sacramento, Calif. $3,650,000. Development and production of Minuteman III stage III motors. Space and Missile Systems Organization, AFSC, Los Angeles, Calif. F04694-67-C-0004 P287.

8—The **Boeing Co.**, Seattle, Wash. $9,816,100. Modernization of ground equipment for the Minuteman III weapon system. Ogden, Utah, and Seattle. Space and Missile Systems Organization, AFSC, Los Angeles, Calif. F04701-69-C-0159.

—**Victor Comptometer Corp.**, Rogers, Ark. $1,423,440. Component parts for munitions. Ogden Air Materiel Area, AFLC, Hill AFB, Utah. F42600-70-C-0652.

—**AAI Corp.**, Cockeysville, Md. $4,453,413. Design, development, fabrication, test and installation of an AN/ALQ-T5 electronic warfare training simulator. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33657-70-C-1006.

11—The Ogden Air Materiel Area, AFLC, Hill AFB, Utah, issued the following contracts for SUU-30 munitions dispensers:

Lanson Industries, Inc., Cullman, Ariz. $2,374,236. F42600-70-C-0617.

Crescent Precision Products, Inc., Garland, Tex. $5,547,172. F42600-70-C-0608.

American Electric, Inc., La Mirada, Calif. $1,683,374. F046060-69-A-0166.

12—The Armament Development and Test Center, AFSC, Eglin AFB, Fla., awarded the following contracts for the development, fabrication and tests of a 25mm aircraft gun system, GAU-7/A:

Philco-Ford Corp., Newport Beach, Calif. $1,000,000. F08635-70-C-0080.

General Electric Co., Burlington, Vt. $1,000,000. F08635-70-C-0084.

—**Northrop Corp.**, Hawthorne, Calif. $23,618,565. Long lead time items for F-5 aircraft. F33657-69-C-1289. $16,139,722. T-38 aircraft, spare parts and ground equipment. F33657-70-C-0216. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio.

13—**North American Rockwell Corp.**, Columbus, Ohio. $3,721,000. KMU-353A/B guided bomb kits. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33657-70-C-0336.

14—The Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio, issued the following contracts:

Lockheed Aircraft Corp., Marietta, Ga. $50,000,000. C-5A aircraft. AF33(657)-15053.

General Electric Co., Cincinnati, Ohio. $8,466,100. J-79 engines, spare parts and aerospace ground equipment. F33657-69-C-1285.

15—**General Dynamics Corp.**, Fort Worth, Tex. $56,552,369. F-111 aircraft. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33(657)-13403.

—**General Electric Co.**, Philadelphia, Pa. $4,446,340. Research and development of the Mark 12 reentry system. Space and Missile Systems Organization, AFSC, Los Angeles, Calif. AF 04(694)916.

—**Aerojet-General Corp.**, Fullerton, Calif. $1,948,323. Munition dispensers. Armament Development and Test Center, AFSC, Eglin AFB, Fla. F08635-69-C-0045.

—**Lockheed Aircraft Corp.**, Marietta, Ga. $3,387,778. C-5A spare parts. Detachment 31, San Antonio Air Materiel Area, AFLC, Marietta, Ga. AF33(657) 15053.

—**Centex Construction Co., Inc.**, Dallas, Tex. $1,720,000. Construction of 100 family housing units, Bergstrom AFB, Tex. 75th Combat Support Group, Bergstrom AFB, Tex. F41687-70-C-0224.

18—The following contracts were awarded by the Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio:

General Dynamics Corp., Fort Worth, Tex. $18,000,000. F-111 aircraft. AF-33657-13403.

General Motors Corp., Indianapolis, Ind. $2,389,804. TF-41-A1/A2 turbofan aircraft engines. F33657-67-C-0163.

Lockheed Aircraft Corp., Marietta, Ga. $2,514,473 (contract modification). Production and modification of C-141 aircraft. AF33657-14885.

20—**Hunt Building Marts, Inc.**, El Paso, Tex. $2,740,800. 150 family housing units, Luke AFB, Ariz. F02604-70-C-0133.

—**North American Rockwell Corp.**, Anaheim, Calif. $6,000,000. Research and development of the Minuteman III missile post boost propulsion system. Space and Missile Systems Organization, AFSC, Los Angeles, Calif. F04701-68-C-0040.

—**American Electric Co.**, La Mirada, Calif. $2,597,625. Aircraft ordnance. La Mirada and Long Beach, Calif. Ogden Air Materiel Area, AFLC, Hill AFB, Utah. F42600-70-C-1315.

22—**Lockheed Aircraft Corp.**, Marietta, Ga. $1,217,651. Aerospace ground equipment for C-5A aircraft. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. AF33-657-15053.

26—**General Dynamics Corp.**, Fort Worth, Tex. $1,000,000. F-111 aircraft. Aeronautical Systems Div., AFSC, Wright-Patterson AFB, Ohio. AF33-657-13403.

—**Westinghouse Electric Corp.**, Baltimore, Md. $4,078,400. Electronic countermeasure systems, spares, aerospace ground equipment and applicable data. Warner Robins Air Materiel Area, AFLC, Robins AFB, Ga. F09603-70-C-5140.

—**Litton Systems, Inc.**, Woodland Hills, Calif. $1,501,971. Repair and modification of inertial navigational systems for RC-135 and DC-130 aircraft. Oklahoma City Air Materiel Area, AFLC, Tinker AFB, Okla. F34601-70-D-2719.

—**General Electric Co. and Del E. Webb Corp.** (joint venture), Philadelphia, Pa. $5,393,000. Production and construction of 200 family housing units at George AFB, Calif. F04609-70-C-0132.

27—**Texas Instruments, Inc.**, Dallas, Tex. $1,237,623. Aerospace ground equipment in support of airborne radar equipment for RF-4C aircraft. Aeronautical Systems Div., AFSC, Wright-Patterson AFB, Ohio. F33657-68-C-0379.

—**Consolidated Diesel Electric Co.**, Greenwich, Conn. $6,128,788. Diesel engine driven generator sets (100 and 200 KW) with ancillary equipment and data. Sacramento Air Materiel Area, AFLC, McClellan AFB, Calif. F04606-70-D-0192.

28—**Honeywell, Inc.**, Hopkins, Minn. $3,907,200. Component parts of air munitions. St. Louis Park, Minn. Ogden Air Materiel Area, AFLC, Hill AFB, Utah. F42600-70-C-1321.

—**Curtiss Wright Corp.**, Wood Ridge, N.J. $2,203,791. Overhaul and modification of J-65 aircraft engines. San Antonio Air Materiel Area, AFLC, Kelly AFB, Tex. F41608-70-D-2086.

—**Ajax Hardware Manufacturing Co.**, City of Industry, Calif. $3,337,900. Component parts of air munitions. Armament Development and Test Center, Eglin AFB, Fla. F08635-70-C-0217.

—**Continental Electronics Manufacturing Co.**, Dallas, Tex. $3,500,000. Modification of radar systems applicable to Minuteman III. Space and Missile Test Center, AFSC, Vandenberg AFB, Calif. F04697-70-C-0257.

—**National Lead Co.**, Toledo, Ohio. $2,358,047. Component parts for air munitions. Batavia, N.Y. and Toledo. Ogden Air Materiel Area, AFLC, Hill AFB, Utah. F42600-70-C-1322.

—**Lockheed Aircraft Corp.**, Sunnyvale, Calif. $3,750,000. Design, development, assembly, test and launch support of an unmanned spacecreft. Space and Missile Systems Organization, AFSC, Los Angeles, Calif. F04701-70-C-0035.

—**Kollsman Instrument Corp.**, Elmhurst, N.Y. $4,430,195. CPU-46/A computers, mounting trays, spare parts and data. Aeronautical Systems Division, AFSC, Wright-Patterson AFB, Ohio. F33657-70-C-1024.

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Meetings and Symposia

AUGUST

Computer Methods of Structural Shell Analysis, Aug. 3–6, at Palo Alto, Calif. Co-sponsors: Air Force Flight Dynamics Laboratory and Lockheed Missiles and Space Division. Contact: Air Force Flight Dynamics Laboratory (FDTR), Wright-Patterson AFB, Ohio 45433. Phone (513) 255–5651.

Aurora and Airflow, 1970, Advanced Study Institute, Aug. 3–14, at Queen's University, Kingston, Ontario, Canada. Sponsors: Advanced Research Projects Agency, Defense Atomic Support Agency, Office of Naval Research, Lockheed Palo Alto Research Laboratory and the National Research Council of Canada. Contact: Dr. Billy M. McCormac, Lockheed Palo Alto Research Laboratory, 3251 Hanover St., Palo Alto, Calif. 94304.

1970 International **Radiation Effects in Semiconductors** Conference, Aug. 24–28, at the State University of New York, Albany, N.Y. Sponsors: Office of Naval Research, Air Force Cambridge Research Laboratory and the State University of New York, Albany. Contact: Comdr. C.W. Causey, USN, Code 422, Office of Naval Research, Washington, D.C. 20360, phone (202) OXford 6–5673; or C.D. Turner, Air Force Cambridge Research Laboratory, (CRWH), L.G. Hanscom Field, Bedford, Mass. 01730, phone (617) 274–6100 Ext. 4034.

SEPTEMBER

Aircraft Wake Turbulence Symposium, Sept. 7–10, at Seattle, Wash. Co-sponsors: Air Force Office of Scientific Research and Boeing Scientific Research Laboratories. Contact: Milton Rogers, Air Force Office of Scientific Research (SREM), 1400 Wilson Blvd., Arlington, Va. 22209. Phone (202) 694–5567.

Advanced Experimental Techniques in the Mechanics of Materials, Sept. 9–11, at San Antonio, Tex. Co-sponsors: Air Force Office of Scientific Research and the Southwest Research Institute. Contact: Dr. J. Pomerantz, Air Force Office of Scientific Research (SREM), 1400 Wilson Blvd., Arlington, Va. 22209. Phone (202) 694–5568.

Charge Spin and Momentum Density Sagamore Conference III, Sept. 9–13, at Aussois near Grenoble, France. Sponsors: Army Research Office-Durham, International Union of Crystallography and Massachusetts Institute of Technology. Contact: Dr. Robert Mace, Dir., Physics Div., Army Research Office-Durham, Box CM, Duke Station, Durham, N.C. 27706. Phone (919) 286–2285.

Laser in Science and Technology Symposium, Sept. 15–16, at the University of Washington, Seattle, Wash. Co-sponsors: Air Force Office of Scientific Research and the University of Washington. Contact: Milton Rogers, Air Force Office of Scientific Research (SREM), 1400 Wilson Blvd., Arlington, Va. 22209. Phone (202) OXford 4-5567.

1970 **Air Force Association** National Convention and Aerospace Briefings and Displays, Sept. 21–24, at the Sheraton Park Hotel, Washington, D.C. Sponsor: Air Force Association. Contact: Air Force Association, 1750 Pennsylvania Ave., NW, Washington, D.C. Phone: (202) 298–9123.

OCTOBER

Fourteenth Annual **Organic Chemistry Conference**, Oct. 8–9, at Natick, Mass. Sponsor: Chief of Research and Development, Dept. of the Army. Contact: Dr. Louis Long Jr., Head, Organic Chemistry Group, PRL, Army Natick Laboratories, Natick, Mass. 01760. Phone (617) 653–1000 Ext. 2414.

First **Western Space Congress**, Oct. 27–29, at Santa Maria, Calif. Sponsor: Vandenberg Scientific and Technical Societies Council. Contact: B. Z. Woods, Exhibits Chairman, P.O. Box 1134, Santa Maria, Calif. 93454.

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Computer-Letters Manage Missile Parts Production

Defense contracts for repair parts are usually low dollar, high density awards that can be plagued by documentation problems and subject to fluctuating supply system demands. Government procurement regulations require buying on a competitive basis, where possible, and that small business concerns be given maximum considerations. New contractors often are manufacturing repair parts for the first time, using drawings produced by the original contractor. Supply system demands often change after initial request and require a management system equally flexible and responsive.

To eliminate problems connected with buying missile repair parts, the Procurement and Production Directorate of the Army Missile Command, Redstone Arsenal, Ala., devised a letter-computer management system. A series of standard letters, initiated at appropriate times by the computer and printed, with proper envelope, on a line printer, have been developed to speed up solutions to four problem areas in repair parts contractor performance:

- To prevent inadequate documentation early in production, the first letter is sent to the manufacturer 90 days before contract delivery date and alerts him to the fact that he has a contract or purchase order, verifies all the controlling numbers involved, and asks him to check for any discrepancies.
- To prevent slippage, 60 days before scheduled delivery, a second letter asks the contractor to notify the contract administrator in the cognizant Defense Contract Administration Services Region, if there are problems likely to cause a slippage in delivery.
- To accelerate the delivery schedule in the event stockage condition requires it, another computer-printed letter asks the manufacturer if it is possible to ship early at no extra cost to the Government. Stockage levels, functional criticality, and deployment codes programmed into the computer initiate this letter which is then screened by Missile Command managers. This automatic action answers unanticipated demands in the supply system without exceptional management attention.
- To provide incentive to deliver or begin early problem solution, a letter is sent to the contractor 10 days after his contract becomes delinquent, and a follow-up letter is sent 40 days after the scheduled date. These letters tell the manufacturer that he is delinquent and ask for the reason for slippage, or that he verify the shipping information if records are in error.

With all the letters, a self-addressed envelope is enclosed for convenience of the recipient, and the letters request that answers be made on the reverse side of the letter to increase responsiveness.

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